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SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

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Video-Tape Recording Interchangeability Requirements

By K. B. BENSON

The use of video tape in broadcasting service often requires that recordings be played back with a different head assembly than was employed for the original recording. If such interchangeability of head assemblies is to provide optimum quality, it is essential that close control of many manufacturing parameters and operating standards be maintained. In present-day multiple head equipment, mechanical dimensions of particular importance include those relating to the video-track azimuth, pitch, and width as well as the angular placement of the four rotating heads. Essential electrical parameters include the value of carrier frequency corresponding to reference video levels. In addition, response-frequency characteristics of audio, video and carrier frequency channels must be standardized. The significant factors are discussed relative to proposed industry standards and current CBS Television Network practices.

Background

The first use of video tape by CBS in November, 1956, and shortly thereafter by other networks, was for the regional delay of program transmission in order to accommodate time-zone differences across the United States.[1] This service permits the recording and playback of each program transmission to be accomplished on the same video-tape unit, and consequently, requires merely the elementary operations of record, rewind and playback. In fact, frequently it is not necessary to remove the tape from the video-tape transport between the start of recording and finish of playback. Therefore, the electrical and mechanical characteristics of the equipment may be entirely nonstandard as long as they result in acceptable playback performance. Set-up adjustments can be made to correct shortcomings of a particular head assembly or recording equipment even though the recorded magnetic characteristics may be completely incompatible with the requirements of other heads or recorders. Thus, with a video-tape broadcasting operation of such limited complexity, at that time the need for interchangeability among recorders was not particularly urgent.

However, before long, realization by production personnel of the potentialities of video tape created a demand for greater operational flexibility.[2] Initially, the first expanded utilization of video tape was for the recording of complete programs, or inserts for live programs, at times when talent or production facilities were more conveniently available than at the scheduled air-time. The requirements for this type of operation are similar to those for time-zone delay transmission with one important exception — the playback of the tape may be scheduled for a time after the head used for the recording has been worn out from other programming use. Originally, because the uniformity of head manufacture did not assure acceptable playback on heads other than the one used for recording, it was necessary to hold the recording head assembly in storage with the tape until the time of air playback.

At the present time, design improvements and production control have developed to the degree where it is practical to playback on any properly manufactured and properly adjusted head assembly. Furthermore, the more rigorous demand for the ability to playback taped program material made up by splicing together tape segments recorded on different heads can also be accommodated if the original recordings are up to par. In other words, complete interchangeability of head assemblies exists, providing the necessary stringent precautions regarding manufacture and adjustment are observed. As a result, techniques which are common in the motion-picture business have been adopted for many of the more involved television productions. For example, many shows are no longer recorded in a straight run-through. Instead, where production problems dictate, scenes or even portions of scenes may be recorded out of time sequence. Thus, in many cases, the transition between tapes recorded on different heads may occur instantaneously in the midst of a scene.

Survey of Interchangeability Factors

It is apparent from the foregoing that interchangeable performance has had to be developed to the level where not a single operating adjustment is required in order to accommodate tapes made on different recorders or head assemblies. In order to achieve such highly desirable flexibility in video-tape operation, rigid control must be exercised over many parameters. The magnitude of the problem is indicated by the following tabulation of the most significant factors to be considered:

Video Head:
- Quadrature alignment
- Gap azimuth alignment
- Vacuum guide position
- Recorded track dimensions

Control Track:
- Control signal phasing
- Edit pulse phasing
- Recorded signal levels
- Track width and placement

Video Signal:
- Carrier frequency for blanking level
- Carrier frequency for white level
- Pre-emphasis
- Post-emphasis
- Video bandwidth

Audio Head and Track:
- Track width and placement
- Gap azimuth alignment

Audio Signal:
- Recorded signal level
- Pre-emphasis
- Post-emphasis
- Audio bandwidth

Magnetic Tape:
- Physical dimensions and properties
- Magnetic properties
- Reel dimensions

Presented on April 6, 1960, at the NAB Engineering Conference by K. B. Benson, Engineering Dept., CBS Television Network, 485 Madison Ave., New York 22.

Fig. 1. Quadrature error: A timing error of $0.12\mu sec$ is evident as a horizontal displacement of the band of picture lines corresponding to the head in error.

Fig. 2. Incorrect horizontal positioning of vacuum guide: A difference between recording and playback velocities of the pole-tips relative to the tape surface causes a timing error which is evident as a sawtooth serration of vertical lines.

As will be evident in the subsequent discussion, several of the items listed cannot be adjusted or corrected except during manufacture. In these cases, the tape equipment user's control is limited to a periodic check in order to determine if the equipment remains within the permissible limits of tolerance. However, the majority of the factors are subject to set-up or operating adjustment and must be held under careful control if interchangeable performance is to be comparable to that achieved in noninterchangeable operation.

Video Head

One of the most objectionable degradations encountered in video-tape reproduction is the geometric distortion resulting from timing errors in the operation of the head assembly. Although the effect upon the picture always is evident as a horizontal displacement of one or more scanning lines, the cause may be attributed to three fundamental variations from optimum performance: (1) a uniform time displacement resulting from an error in quadrature placement of one or more pairs of pole-tips around the head drum or wheel, (2) incorrect velocity of the pole-tips relative to the tape because of a difference between the recording and the playback horizontal* positioning of the vacuum guide relative to the axis of head rotation, and (3) nonuniform velocity of pole-tips relative to tape because of an incorrect vertical* positioning of the vacuum guide.

CBS has developed electronic circuitry which is capable of automatically correcting timing errors resulting from head shortcomings. This is accomplished by the automatic insertion of an appropriate video delay at the start of each television line during playback. This development was first demonstrated jointly by CBS and Ampex at the April, 1960, SMPTE Convention in Los Angeles, and will be made available in commercial form. However, since the degree of automatic correction obviously is limited to a finite value, the availability of such equipment should not be permitted to encourage any relaxation in precise control of variations in head assembly parameters. Furthermore, in order to avoid noticeable horizontal displacements in playback on present-day equipment and on future equipments that may not be equipped with automatic correction, it is essential that in all cases an exceptionally high degree of accuracy in head assembly and adjustment be achieved in head manufacture and maintained in operation.

The precision required is indicated by the fact that a timing error in the order of $0.05\mu sec.$ in a first generation playback is discernible at normal viewing distance on a picture monitor. This is equivalent to a linear deviation on the tape of 0.0001 in. or an angular error in head rotation of roughly 0.005°. In the case of second or third generation playbacks the possibility of errors being cumulative necessitates that variations be limited to a figure appreciably less than 0.05 μsec. In current CBS practice, the maximum error permitted in any single head assembly is 0.02 μsec. This requires routine measurement of quadrature alignment, vacuum guide position, and gap azimuth.

In addition to the distortions in geometry of the playback picture, errors in head dimensions or mechanical alignment can cause other picture degradations, most noticeable of which are an increase in noise level or poor amplitude-frequency response. Checks of gap azimuth and recorded track dimensions are required in order to determine if such faults are attributable to the video head assembly.

Quadrature Alignment: Figure 1 illustrates a $0.12\mu sec$ error in timing of picture elements produced by an error in the quadrature placement of one gap. In addition to the uniform displacement of the scanning lines picked up by the one head which is out of quadrature, a smoothly varying displacement of all lines is introduced because of the slow recovery of the horizontal locking circuits in the picture monitor to the abrupt timing changes.

It is important to check periodically for any shift in quadrature in the event that (a) any slippage or damage has occurred in the quadrature adjustment screws or (b) the pole-piece gaps are not coincident with radii of the drum. The latter will produce a shift in the effective angular position of the gap as the pole-tips wear during normal use.

Quadrature errors unacceptable for interchangeable operation can be detected easily, and with sufficient accuracy, very simply by a recording and playback on the head assembly in question. During playback, an adjustment in capstan tracking so that each of the four heads picks up the track recorded by the adjacent head will cause the quadrature error between two heads to appear as a horizontal displacement in the playback signal. Insertion of appropriate calibrated delay correction between the preamplifiers and switcher will provide a quantitative measure of error. It has been noted that an effective change in quadrature accompanies a change in the driving signal amplitude employed for recording. Therefore, all recording drive signal amplitudes must be optimum for normal recording and playback, if the measurements are to be meaningful.

* Horizontal and vertical in reference to the vacuum guide positioning relate to a horizontally mounted tape-transport system. The nomenclature must be modified in order to be applied to a vertically mounted tape transport.

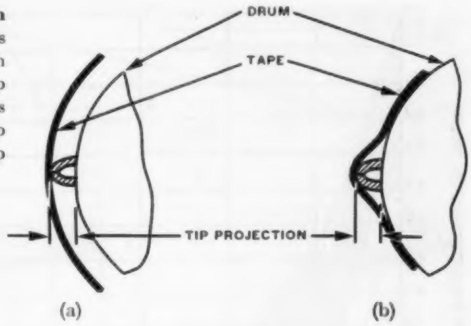
A more sophisticated pulse technique for quadrature measurement which has the distinct advantage of eliminating any errors resulting from variations in recording drive adjustments or electrical delays has been developed by the Ampex Corp. With the head locked in a stationary position and excited with a direct current of a few milliamperes, a single longitudinal track is recorded along the tape. Playback of this tape with the head assembly rotating in the normal manner will produce a series of pulses sequentially from each head. Using an oscilloscope with an appropriate sweep time-base and scale, an examination of the comparative intervals between pulses will reveal the accuracy of head quadrature placement.

Horizontal Positioning of Vacuum Guide: The timing of the playback signal is dependent upon the velocity of the rotating pole-tips of the video head relative to the particles of oxide on the tape surface. This velocity factor can be controlled by a change in pole-tip penetration into the tape which, in turn, is a function of the position of the vacuum guide relative to the axis of head rotation. If the vacuum guide horizontal position during playback differs from that used for recording, displacements are produced in the playback picture similar to those illustrated in Fig. 2. The diagrams in Fig 3 represent schematically the head and tape relationships for two positions of the vacuum guide. For example, in Fig. 3(a) the pole-tips are shown barely in contact with the tape surface. In other words the tip penetration into the tape is negligible.

Figure 3(b) illustrates the effect of a repositioning of the vacuum guide relative to the heads so that the *pole-tip penetration* of the tape equals the *pole-tip projection* above the drum surface. An increase in pole-tip penetration in excess of pole-tip projection will result in a penetration of the tape by the drum surface in addition to that of the pole-tip. The movement of the vacuum guide toward the heads and drum, and the accompanying increase in tip penetration into the tape, causes an elongation or stretch of the tape at, and immediately adjacent to the point of contact with the pole-tips. The result is an effective decrease in velocity of the pole-tips relative to the particles of the oxide surface. Thus, the particles of oxide are moved further apart by the stretching process and, assuming the velocity of head rotation is constant, a longer time is required for the pole-tips to traverse the same particles than in the case of lesser penetration.

Conversely, if the vacuum guide is moved away from the pole-tips, the tape shrinks toward its normal unstretched dimensions and the effective velocity of pole-tips relative to tape oxide surface increases. Fortunately, the characteristic of tape stretch varying with pole-tip penetration provides an automatic correction for the reduction in peripheral velocity of the pole-tips as their projection above the drum surface is reduced by normal wear. Over the normal range of pole-tip projection encountered in the life of a head, the necessary compensating distortion of the tape surface is provided when the position of the vacuum guide relative to the pole-tip axis of rotation is fixed.

Fig. 3. Relationship between tape and pole-tips: (a) Pole-tips are barely making contact with the tape surface. (b) Pole-tip penetration into tape causes stretch of tape. As shown pole-tip penetration is equal to pole-tip protection.



In terms of practical operating adjustments this indicates that the correct value of tip penetration, under any condition of tip projection, is equal to the tip projection plus or minus the arbitrary constant which has been chosen as an operating standard. This can be demonstrated effectively by the playback of a normally recorded tape upon a head assembly having pole-tips of widely different heights above the drum. For example, it will be found that, with proper positioning of the vacuum guide, no geometric distortion of the playback picture will occur even though the pole-tip heights differ by over one mil.

Thus, the flexibility of self-compensation brings with it the need for standardization. It is essential for interchangeability that all tapes be made with the same relative velocity between the pole-tips and the tape surface. This condition can be met for all values of tip projection if the position of vacuum guide relative to the axis of head rotation is fixed.

Standard Horizontal Position of Vacuum Guide: The choice of a standard value for the horizontal position of the vacuum guide is influenced by two primary considerations of conflicting significance:

(a) The vacuum block must be positioned close enough to the head axis to provide adequate magnetic contact between the tape and pole-tips at the low values of tip projection encountered near the end of the life of a head. Since the vacuum block position relative to the head axis is constant, this will result in a comparatively high value of penetration for new heads which have a high tip projection above the drum.

(b) A high value of tip penetration accompanying a close positioning of the vacuum guide to the heads produces excessive head and tape wear.

Warranting secondary attention is the lesser but not insignificant effect of high penetration upon head servo stability, particularly during the passage of splices. As the penetration is increased, the frictional loading of the head drum also increases and, if constant speed of rotation is to be maintained, must be overcome by additional driving power from the head servo system. If the penetration is such that the servo system is operating near its maximum capability, the higher penetration resulting from the added thickness of splicing tape can produce a momentary loss in rotational velocity. The effect is a horizontal shift in portions of the reproduced picture as though there were a loss in horizontal synchronization.

With these factors in mind, in July, 1959, CBS undertook an extensive investigation into video-head operation in an attempt to determine whether the standard of tip penetration in use at that time was optimum or whether a change to some other value was justified. The equipment manufacturers concurrently began a parallel investigation.

Laboratory measurements revealed that the then-current standard placed the tape under tension across the peripheral surface of the drum as well as at the pole-tips. The advantages claimed by the proponents of this method of operation were: (a) the burnishing action of the pole-tips and the drum reduces dropouts on many new tapes after a few passes; and (b) long life and high signal output are achieved because the high value of tip penetration permits the use of heads on which wear has reduced the tip projection to as low as 0.6 mil above the drum. On the other hand there are disadvantages which, from an operating standpoint, dictate the desirability of a lesser penetration. For example, the use of expensive tape recorders and highly skilled technicians to perform a final burnishing operation on tape is not economical. This rightfully is a manufacturing operation which can be performed more economically by the tape supplier. Furthermore, the maximum

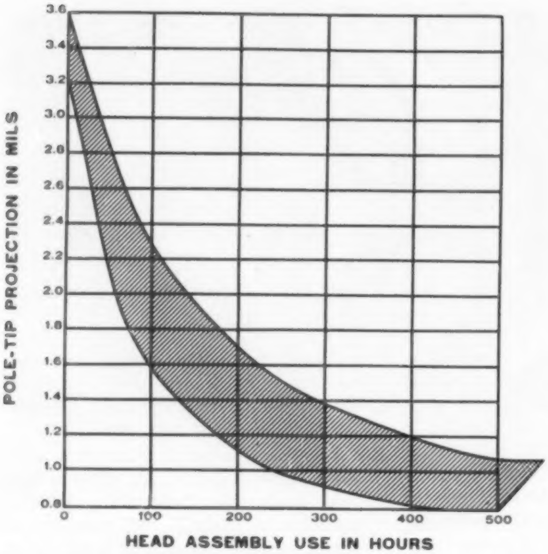


Fig. 4. Pole-tip projection vs. use: The use of video head assemblies results in a reduction of pole-tip projection. The above envelope summarizes data on pole-tip wear for 24 heads. Head life totaling 5700 hours is represented. It should be noted that for causes other than pole-tip wear, heads may fail prior to the potential maximum life shown.

Fig. 5. Incorrect vertical positioning of vacuum guide: A variation in the velocity of pole-tips relative to the tape surface during the traverse of the pole-tips across the tape causes a timing error evident as a scalloping of vertical lines.

manufacturing tolerance for the dimension from the bottom of the head gap to the drum surface is approximately 1 mil. Consequently, use of heads after the tip projection is reduced to under 1 mil may result at any time in an enlargement of the gap and unusable performance. Of course, also worthy of consideration are the high head and tape wear accompanying the high tip penetration encountered early in the life of a head, and the aforementioned excessive loading of the head motor-drive system.

A further investigation was conducted to determine at what point contact and resultant friction between the tape and drum surface are eliminated. At a tip penetration equal to the tip projection, the contact was found to be very slight. At a tip penetration of 0.5 mil less than tip projection, no contact was found to exist between the tape and drum at any point. These results hold true for new as well as old heads because for interchangeable operation the vacuum guide position relative to the drum is not changed as pole-tip projection decreases with wear.

In an attempt to obtain a meaningful operational evaluation, for a period of ten weeks all of the CBS-New York and CBS-Hollywood video tape facilities were run at the latter value of tip penetration, viz., tip penetration 0.5 mil less than tip projection. Although head life was found to be very high, it was noted that frequently heads were retired from service because of loss in contact between the pole-tips and the tape. The condition occurred when the pole-tip projection above the drum was in the order of 1.2 mils. Since this figure is appreciably above the 1.0-mil limit for the bottom of the gap, because of the necessary premature retirement, several hours of head life were being lost. The use of a higher, intermediate value of penetration was indicated as more nearly optimum for economical operation.

Accordingly, it was decided in September, 1959, to change over to a compromise value of tip penetration equal to the tip projection. This value appeared to be the maximum which could be employed without incurring appreciable friction between the tape and drum. In addition, since it results in approximate coincidence of the centers of the vacuum guide curvature and head rotation, a more uniform deformation of the tape due to the tip penetration may be expected. Data representing the performance under this condition of operation are shown in Fig. 4. The head wear, indicated as a reduction in tip projection above the drum, is plotted against hours of operation. The envelope encompasses the data taken on 24 heads at CBS Hollywood over a period from September 21, 1959, to January 7, 1960; 5,700 hours of head life are represented. A possible life of several hundred hours with good head-to-tape contact was found to be normal. The average curve approaches an asymptote of approximately 1-mil tip projection. This value is equal to the maximum tolerance for the bottom of the gap above the drum periphery. Thus, a large percentage of the life span is under conditions where the usable gap height is small and a high level of playback signal output is produced.

Vertical Positioning of Vacuum Guide: A nonsymmetrical positioning of the vacuum guide about the circle of pole-tip rotation will produce nonuniform stretch of the tape throughout the scan of the video heads. Even though the absolute peripheral velocity of the pole-tips is constant, their velocity relative to the recorded tracks will vary in accordance with the nonuniform tape stretch. In other words, the velocity at the start of a scan across the tape may differ from that at the end of the scan. The effect upon the picture is a scalloping of vertical lines as shown in Fig. 5.

The criterion for proper vertical positioning of the vacuum guide is a value of tip penetration and accompanying tape stretch at the top edge of the tape equal to that at the bottom edge. This characteristic provides a very accurate and simple alignment test. By reversing a tape upon playback, any differences in stretch will produce double amplitude indication of the timing error. If the guide was set correctly for both recording and playback, no scalloping should be observed in either the normal or reverse playback. Of course, in order to maintain servo control for this test, it is necessary to have recorded the 240-cps control signal on the audio track as well as on the control track. This provides a control track on both edges of the tape.

Where a rapid operational check of the vertical positioning of the vacuum guide is required, this can be accomplished by backing the guide away from the head to the point where almost all contact between the tape and heads is lost. If the vertical position is symmetrical with respect to the circle of head rotation, the playback signals at the start and finish of head travel across the tape will be equal. The waveform as observed

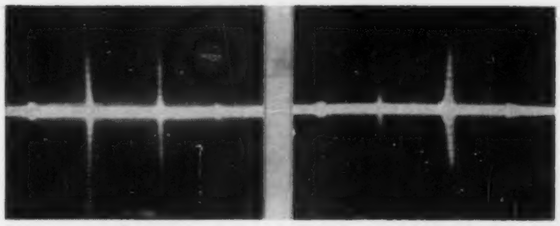

(a) (b)

Fig. 6. Indication of vacuum guide vertical position: Output signal waveforms from a preamplifier under conditions wherein the pole-tips are barely in contact with the tape show in (a) equal signal outputs at the start and finish of a head traverse across the tape indicating correct symmetrical positioning of the guide relative to the circle of head rotation and in (b) low output at the start of the head traverse indicating the guide is positioned too high.

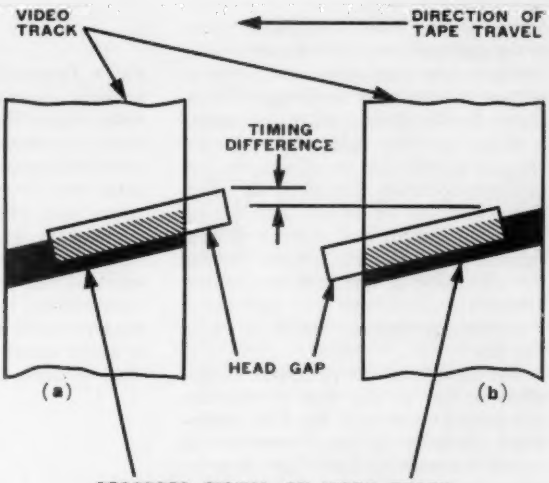


Fig. 7. Relationship between the azimuth error and playback timing: When the gap of the head is not in line with the direction of tape travel, a mistracking of the playback head can cause a change in timing of the signal. Two cases of mistracking are shown. The playback signal in (a) will be advanced in time compared to that in (b).

at the preamplifier output will appear as pulses of equal amplitude as shown in Fig. 6(a). If the position is nonsymmetrical, the output will be unequal. The unequal waveform shown in Fig. 6(b) illustrates the case where the vacuum guide is positioned too high.

Azimuth: The angular position of the gap between the pole-tips of the head relative to the direction of tape travel is referred to as azimuth. If a maximum signal-to-noise ratio and high-frequency response are to be obtained, it is essential that the azimuth angles of the recording and playback heads are identical.

Any difference between the two is similar in effect to a widening of the playback head gap and results in a loss in signal output and bandwidth. In addition, if the gaps are not parallel to the movement of the tape past the head assembly, an error in quadrature can occur. This last effect is not limited to interchangeable playback. It can be demonstrated on a head playing back its own recorded track by shifting capstan phase so as to cause slight mistracking. This effect serves as a convenient check for azimuth error. The diagram in Fig. 7 indicates, in an exaggerated manner, how, by a shift in tracking of the head from the right in (a) to the left in (b), pickup of the same signal can be retarded in time.

Recorded Track Dimensions: In addition to azimuth errors, loss in signal-to-noise ratio with interchangeable operation can be attributed to nonuniformity in width or position of the magnetic tracks laid down by the recording head or of the paths traversed by the playback head. A uniformly high noise level throughout a band corresponding to one head indicates that the head is not in the same vertical plane as the other three and the pitch of the tracks is not uniform. A variation in noise level throughout each band can result from the plane of head rotation not being perpendicular to the tape and producing curved tracks. Lastly, a reduction in widths of the heads from standard can produce an increase in noise level.

Although these effects often can be detected by a careful examination of a magnetic development of the recorded tracks, that technique is recommended only as a secondary check. The primary evaluation should consist of a measurement of playback performance using a tape made on a standard head, the critical dimensions of which fall close to the manufacturer's design center.

The signal output of each of the heads should be of uniform level and adequate to override preamplifier noise level. With present-day cascode input circuits, this dictates a peak-to-peak signal level of at least 2 mv. In lieu of more detailed specifications at this time the evaluation, for the most part, must be limited to qualitative observations of picture quality. However, it is expected that in the near future developments now under way will yield more precise measuring techniques.

Control Track

The primary requirement for the recorded control-track signals, other than the obvious ones of adequate level and track width, is a uniform phase relationship to the video-tracks. This characteristic is important in order to avoid the need for readjustment of capstan phasing when playing back recordings made on different head assemblies. In addition, the phase of the edit pulse must be fixed in relation to specific video-tracks so as to indicate the optimum location for a splice. To further facilitate splicing, the phase relationship between edit pulse and control signals must be such that the former can be easily distinguished by magnetic detection systems.

Edit Pulse: Alternating with the video-tracks on a recorded tape are unmagnetized guard-band areas necessary to prevent crosstalk between adjacent tracks. The purpose of the edit pulse is to indicate the proper unmagnetized guard-band for a splicing cut.

Since some minor disturbance very often occurs during passage of a splice, it is essential that splicing cuts are made after the vertical synchronization signal in order to avoid spurious triggering of receiver vertical scanning circuits. The reason for this can be seen from the waveforms in Fig. 8. The solid lines indicate the normal grid voltage characteristics of the usual vertical scanning oscillator in a receiver. The vertical synchronizing pulse drives the grid into conduction and thus triggers the oscillator cycle at the

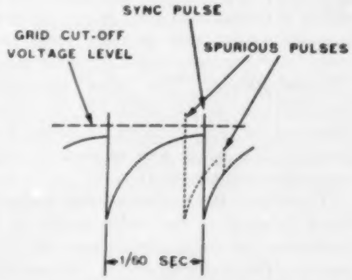


Fig. 8. Effect of spurious signals upon receiver vertical scanning synchronization: Loss of synchronization is more likely to result from a spurious signal occurring before rather than immediately after the vertical synchronizing pulse.

appropriate time for start of vertical scanning. Any small disturbance prior to the synchronizing pulse also can drive the grid into conduction and cause a premature start of vertical scan. This is shown by the dashed curve. However, a similar spurious pulse after the synchronizing pulse has no effect upon the oscillator operation. Therefore, the splice line as indicated by the edit pulse should be located after the vertical synchronizing signal interval. Current practice records the edit pulse in line with the second video-track guard band after the vertical synchronizing interval. This is shown in Fig. 9.

The majority of the video-tape equipment in use at this time records the edit pulse at field rate. The CBS equipment currently is being modified to record the pulse at frame rate so as to minimize the possibility of a half line shift during passage of a splice. Use of the frame pulse in conjunction with more precise head servo equipment recently developed will eliminate significant shifts in horizontal phasing. The frame pulse is timed to identify the recorded vertical blanking interval which is preceded by a full rather than half horizontal picture line.

Control-Track Signal Phasing: The purpose of the control-track signal is to provide a timing reference during playback for the capstan servo system. The capstan with its accompanying control system maintains the velocity of tape travel relative to the video head so that during playback, the pole-tips trace precisely the magnetized track record laid down during recording. The degree of accuracy required for acceptable playback performance is impressive. An error of a few degrees at the control-track frequency of 240 cps can produce a visible reduction in signal-to-noise ratio.

The problem is most acute in the case of spliced tapes. If two spliced tapes have not been made with an identical value for phasing between the control track and video tracks, it is necessary to correct for the difference by manual adjustment of the capstan phasing control. Any such manual operation following a splice is undesirable since it results in a momentary increase in noise level because of the mistracking during the time of readjustment. The other apparent disadvantage is the need for the close attention of an operator to note the passage of a splice and to perform the correction adjustment.

Therefore, the phase of the control track relative to the video tracks is a parameter of major significance for the success of interchangeability. At present the control track is placed so that the point of zero magnetization occurs near the edit pulse. To facilitate locating the edit pulse by magnetic development or magnetic sensing, it has been recommended by the SMPTE Video-Tape Recording Committee that the control track phasing be changed so as to shift the point of peak magnetization to be coincident with the edit pulse. The proposed positioning of the recorded tracks is shown in Fig. 9.

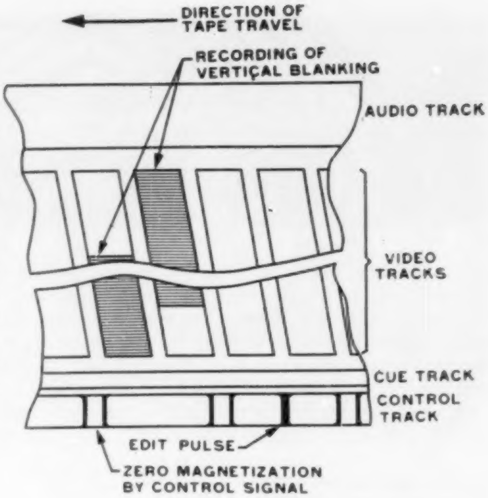


Fig. 9. Proposed relationship between control track and video tracks: The area of minimum magnetization of the oxide by the control signal is in phase with every other video guard band. The edit pulse is recorded in phase with the video guard band between the areas of zero control signal magnetization. The control track recording is portrayed as it would appear from a magnetic development of the tape.

The Video Signal

One of the major problems in any phase of television program transmission is the consistent maintenance of uniform video signal levels. In video-tape recording and playback these parameters are dependent not only upon the gain of the various video amplifiers, but also upon the deviation employed for the frequency modulation of the carrier signal applied to the recording heads. Second in importance to level control is the choice of pre- and post-emphasis for optimum compromise between video bandwidth and signal-to-noise ratio.

Carrier Deviation: The choice of deviation frequencies is dependent upon two opposing factors: (a) the bandpass limitation of the tape and head combination, and (b) the need for a maximum value of signal-to-noise ratio. The signal-to-noise ratio will vary directly with the peak-to-peak magnitude of the deviation. Therefore, it is desirable to modulate the carrier over as wide a band as the system elements will permit. However, if the high-frequency cutoff of the head and tape is exceeded, a distortion of peak white signals is produced. In some types of playback circuitry this results in a failure of limiting action prior to demodulation and permits the random noise from the tape and preamplifier to be amplified to full signal level by the high-gain amplifiers. The resultant noise and streaking in peak white are very objectionable in appearance as can be seen in Fig. 10. In other circuits the effect merely is a loss in peak whites similar to that produced by a peak limiter. It is apparent that the maximum frequency deviation must be limited to that which can be accommodated by any or all heads. A thorough investigation was conducted over a period of several months by the equipment manufacturers and the broadcasters in order to determine a suitable figure for the deviation corresponding to modulation by reference white level. The minimum cutoff encountered with production head assemblies indicated 6.8 mc as a safe operating value.

The lower limit of frequency modulation swing for monochrome recording must be above the 4.5-mc video channel normally employed for television transmission in order to avoid undue interference between the carrier and video signals. Practical low-pass filter circuits for the video bandwidth dictate the use of a compromise value of 5 mc for blanking level modulation. These modulation frequencies are being recommended as a Standard Practice by the SMPTE Video Tape Recording Committee.

In the case of color television recording, in order to avoid spurious beat signals between the color subcarrier and the tape system carrier, a slightly higher frequency generally is used for blanking level.

Pre- and Post-Emphasis: Current monochrome practice provides a recording amplitude characteristic rising with frequency wherein the 4-mc response is 10 to 12 db above the low-frequency response. In order to avoid overdeviation from the higher frequency components, CBS equipment normally is adjusted to restrict the rise in response to frequencies under 4 mc. It should be noted that a significant portion of the pre-emphasis in the case of the multivibrator oscillator is necessary to overcome loss in response in the circuit and does not contribute to an increase in high-frequency sideband energy.

The question of optimum pre-emphasis, in itself, is a suitable subject for a paper. Considerable investigation al-

Fig. 10. Overdeviation: The carrier deviation produced by the leading transient overshoot of the white level signals are beyond the bandpass of the system and result in a streaked interference pattern following the transition from black to white.

ready under way must be completed before optimum performance is achieved and industry agreement is reached on these characteristics.

Audio Signal

The practices currently in use for the recording and playback of the audio signal in video-tape recording are essentially the same as those employed for audio-only equipment. The pre- and post-emphasis characteristics are those determined by the standard magnetic tape reproducing characteristic specified by the NAB. As for standard program level, in CBS operation this is set at 10 db below the level of a 400-cps signal at which distortion is 3%. Because of the narrower track and the cross-orientation of the magnetic particles, performance is slightly degraded from that of conventional high-quality audio equipment. However, providing it is not necessary to resort to third or higher generation recordings, the performance is adequate for broadcast transmission.

Magnetic Tape

Until very recently there has been only one commercial source for video magnetic tape. Consequently, the problems of uniformity of performance have been relatively few. As more manufacturers enter the field, however, it will be necessary to develop standards in regard to the tape oxide characteristics in addition to the dimensional standards for tape and reels currently being adopted by the SMPTE Video-Tape Recording Committee.[3]

Conclusion

Full interchangeability of video-tape recordings among different playback equipments is a necessary practice in present-day television broadcasting. This mode of operation is being put to daily wide-scale use by a large number of video-tape users. For example, the CBS Television Network currently is running a combined load in New York and Hollywood of well over 1,000 machine-hours a week, almost all of which relies upon the ability to provide acceptable playback performance on a head assembly or video-tape equipment other than that used for recording. However, this cannot be accomplished without an intensive program of operating checks and routine maintenance. It is hoped that the foregoing discussion has made it clear that practical means exist for the measurement and control of the critical factors necessary for the achievement of interchangeable performance on a day-to-day basis.

Acknowledgment

A valuable contribution to the preparation of this paper has been the encouragement and assistance of Howard Chinn, Richard O'Brien, and Price Fish of the CBS Television Network Engineering Department. In addition, the operational data furnished by Helmer Andersen and by Richard Sedia and Harvey Schwartz of the CBS Video Tape Operations in Hollywood and New York, respectively, and by members of the SMPTE Video Tape Committee provided a sound basis for the conclusions reached.

References

1. Howard A. Chinn, "Five months experience with video tape," 35th NARTB Convention, April 8, 1957.
2. R. M. Morris, "Panel discussion of video tape operational experiences"; K. B. Benson, "Video tape production problems"; *IRE Transactions on Broadcasting*, Feb. 1959.
3. C. E. Anderson, "A progress report on television magnetic-tape standardization," *Jour. SMPTE, 69:* 410–413, June 1960.

Errata

May 1960

Progress Committee Report for 1959, pp. 299–345:

On p. 327, col. 2, line 2
For: 10 lm
Read: 10,000 lm

June 1960

"The Performance of Television Camera Lenses," by G. H. Cook, pp. 406–410:

On p. 409, col. 1, par. 5, lines 7–13
For: The zero liminal . . center
Read: The zero liminal unit rating for vignetting, as defined by the BBC, corresponds to a lens yielding a level of illumination in the corner of the picture in excess of 63% of that in the center. A down rating of 1 liminal unit corresponds to a lens yielding a corner illumination of 32% of that in the center.

On p. 407
The Author takes this opportunity to point out that the treatment described here refers to the simplified case of imagery on axis where optical aberrations yield symmetrical light distributions. In the general case for off-axis imagery there will, of course, be a change of phase as well as a change of amplitude at different frequencies and this has to be included in the mathematics associated with this type of assessment.

October 1960

"Fiber Optics—A New Tool in Electronics," by L. J. Krolak, W. P. Siegmund and R. G. Neuhauser, pp. 705–710:

On p. 710, References
Add: 8. A. N. Goldsmith, U. S. patent *2,354,591*, July 25, 1944.

A New Video-Tape Recording System

By NORIKAZU SAWAZAKI, MOTOI YAGI, MASAHIRO IWASAKI, GENYA INADA and TAKUMA TAMAOKI

This new video-tape recording system uses only one revolving head and is capable of continuous recording of the whole TV field on a slant track on the magnetic tape. Problems previously encountered with multiple-head systems are avoided, and simplification in both construction and operation results from this innovation. This system is expected to be particularly effective when used for color video recording. Research on the new video-tape recorder was begun at the Toshiba Matsuda Research Laboratory in 1953, and the new system was established in the laboratory the following year. The first experimental VTR-1 was completed in 1958. The VTR-1 prototype system was demonstrated to the publi: in September, 1959, and commercial production of the new video-tape recorder followed.

FIGURE 1 shows how the magnetic pattern of the new system is placed on the tape as compared with that of the conventional system. The most unusual feature of the new system is that it records the whole picture of one television field in one long track on the tape, using only one rotating head.

As shown in Fig. 2, the tape is made to run in a helical loop around the cylinder. This cylinder is divided into two parts, an upper and a lower, and a rotating head disc is provided at the gap between the two, so that the recording head may rotate at a high speed synchronized with the field frequency making contact with the tape at the gap of the cylinder.

The tape is fed at a lower speed, however, so the locus of the contact of the recording head with the tape forms evenly spaced slant tracks on the tape.

In planning the design for the first model, two systems of recording video signals were discussed. Finally the one-head system, which is described in some detail here, was chosen. The other idea that was considered was a two-head system, which is shown in Fig. 3.

Video Recording Mechanism

Figure 4 shows the tape transport mechanism. The capstan motor is driven by a 60-cycle current formed from the vertical synchronizing pulse to give a tape speed of 15 in./sec.

In order to reduce the wear rate of the tape, compressed air is caused to flow through many small holes in the cylinder.

Magnetic Pattern on the Tape

As in the conventional system, a tape two inches wide is used. The track corresponding to a single field is 26.5 in. long and 9.9 mils wide. Tracks for successive frames are evenly spaced at a pitch of 18.9 mils.

Figure 5 shows the magnetic pattern on the tape. The audio track and the control track are recorded along the upper and the lower edges of the tape, overlapping on the video tracks.

In this prototype system, the video tracks overlap both the audio and the control tracks, but this overlapping part of the video tracks coincides with the vertical blanking interval.

Due to the difference of the frequency bands of the recorded signals between the audio or the control track and the video tracks, and to the difference of the head gap directions between the audio or the control head and the video head, interference of the video tracks with the audio or control output is considerably decreased. Consequently such high value of the audio signal-to-noise ratio as indicated below is obtained.

The audio or the control track interferes little with video signal, and these interferences affect only the vertical blanking interval. None of these interferences are apparent in the reproduced picture.

Figure 6 is a block diagram of the new system. It is apparent that the system is extremely simplified in comparison with the conventional video-tape recorder.

Servomechanism

In the head disc servo, a revolving phase-detecting disc has a piece of ferromagnetic material on the edge. This piece induces one pulse in one revolution on a pickup head, which is placed near it.

The disc motor is driven by the phase difference signal between the induced pulse and the vertical pulse of the video signal, in order to make the head pass the edge of the tape at an appropriate phase in a blanking interval.

In recording with the capstan servo, the vertical pulse is recorded on the tape as a control signal, and the motor is driven by a 60-cycle oscillator. The tracking is extremely easy in reproduction with this one-head system.

Jitters

There are two main kinds of jitters on reproduced pictures. One is due chiefly to the wobbling of the head disc, but is not visible on the reproduced picture in normal operation. The other is due to the elasticity of the tape; if the tape transport is not perfect the horizontal synchronizing signal phase changes suddenly

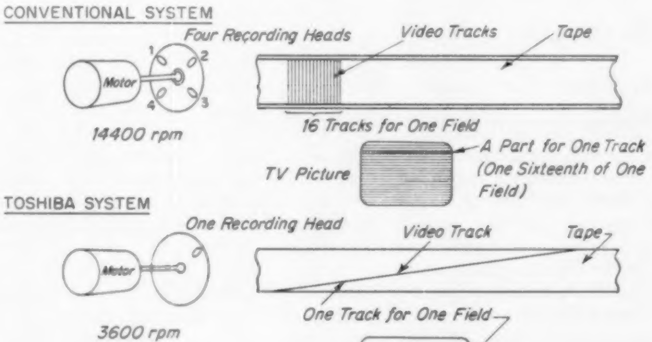


Fig. 1. Comparison of Toshiba video-tape recording system with conventional system.

Presented on May 5, 1960, at the Society's Convention in Los Angeles by Norikazu Sawazaki (who read the paper), Motoi Yagi, Masahiro Iwasaki, Genya Inada and Takuma Tamaoki, Matsuda Research Lab., Tokyo Shibaura Electric Co., Ltd., 72 Horikawa-cho, Kawasaki, Japan.

(This paper was received on June 2, 1960, and in final form on September 19, 1960.)

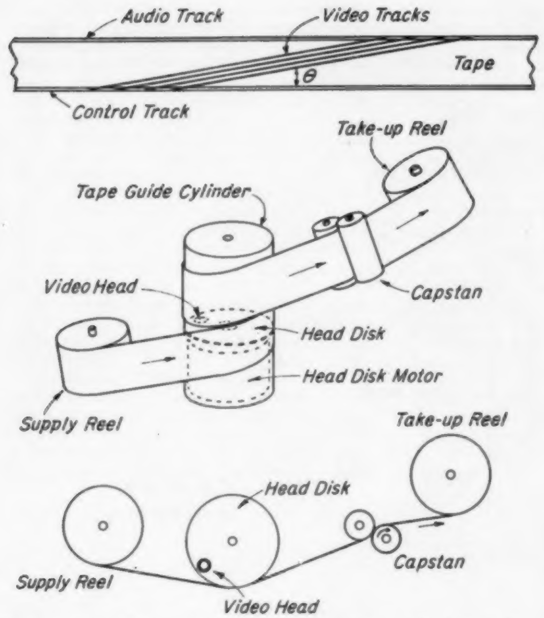


Fig. 2. Recording mechanism of Toshiba (single-head) system.

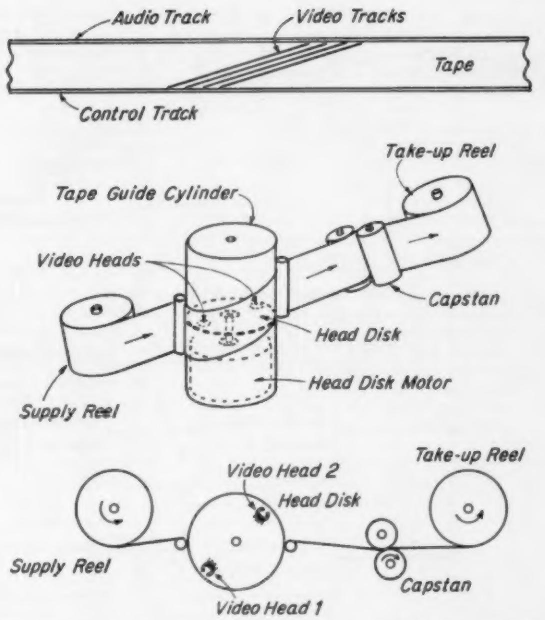


Fig. 3. Recording mechanism of Toshiba (double-head) system.

when the head runs from the tape edge to the adjacent edge. So, the vertical lines in the reproduced pictures by the display equipment with the horizontal AFC are thereby slightly jittered, but only at the top of the picture.

Video System

The frequency-modulation system was adopted for video recording. In this respect, the Toshiba system is similar to the conventional system. However, because of the single video head, both the apparatus and the adjustment are greatly simplified.

In this system, when a video head runs across the tape edges, the reproduced signal is instantly interrupted and noise is generated. The interrupted time interval is about 100–300 μsec in our prototype apparatus. To eliminate this noise, an inhibition gate is used. In a processing amplifier, which is set up to reshape the synchronizing pulse waveform, the horizontal synchronizing pulses of this part of the tape are cleaned up, new horizontal pulses which are generated by an electronic pulse generator are reinserted, and then standard TV signal is reproduced.

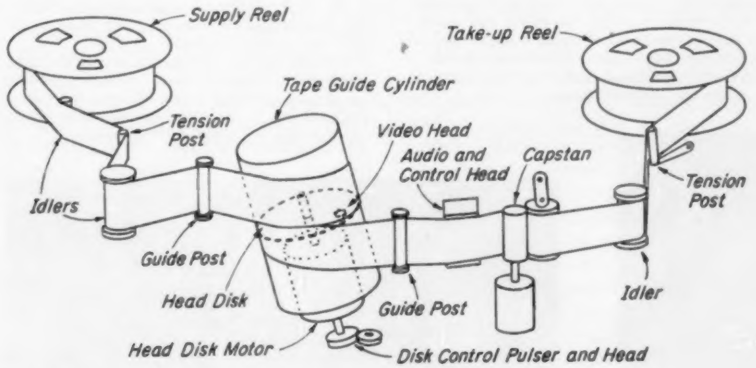


Fig. 4. Tape transport mechanism.

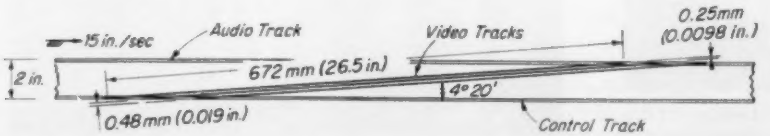


Fig. 5. Magnetic pattern on the tape.

Performance of the Recorder

Figures 7 and 8 show the prototype of this new video-recording system. When this prototype was demonstrated in September, 1959, the following performance values were obtained:

Tape speed: 15 in./sec;
Recording time: 64 min on a $12\frac{1}{2}$-in. reel (or 4800 ft);
Rewind time: approximately 4 min (for 4800 ft);
Video frequency response: gradually decreases from 1 mc and about 6 db down to 4 mc;
Video signal-to-noise ratio: 35 db; and
Audio signal-to-noise ratio: 45 db.

This experimental apparatus has been partly reconstructed and readjusted, and the characteristics have been improved.

Comparison With Other Systems

The most distinctive feature of the Toshiba system is its ability to record the whole picture of one TV field in one long track on the tape. The advantages of this system are:

(1) Operation and adjustment difficulties can be avoided. No special technique is necessary for handling. In general, the new system does not have such problems as "venetian blind," skewing, and scalloping.

(2) The apparatus is simplified. The one-head system uses one amplifier whereas the conventional video-tape recorder uses four. The electric switching devices are thus rendered unnecessary.

(3) Dropouts are greatly decreased. Experimental results have shown that

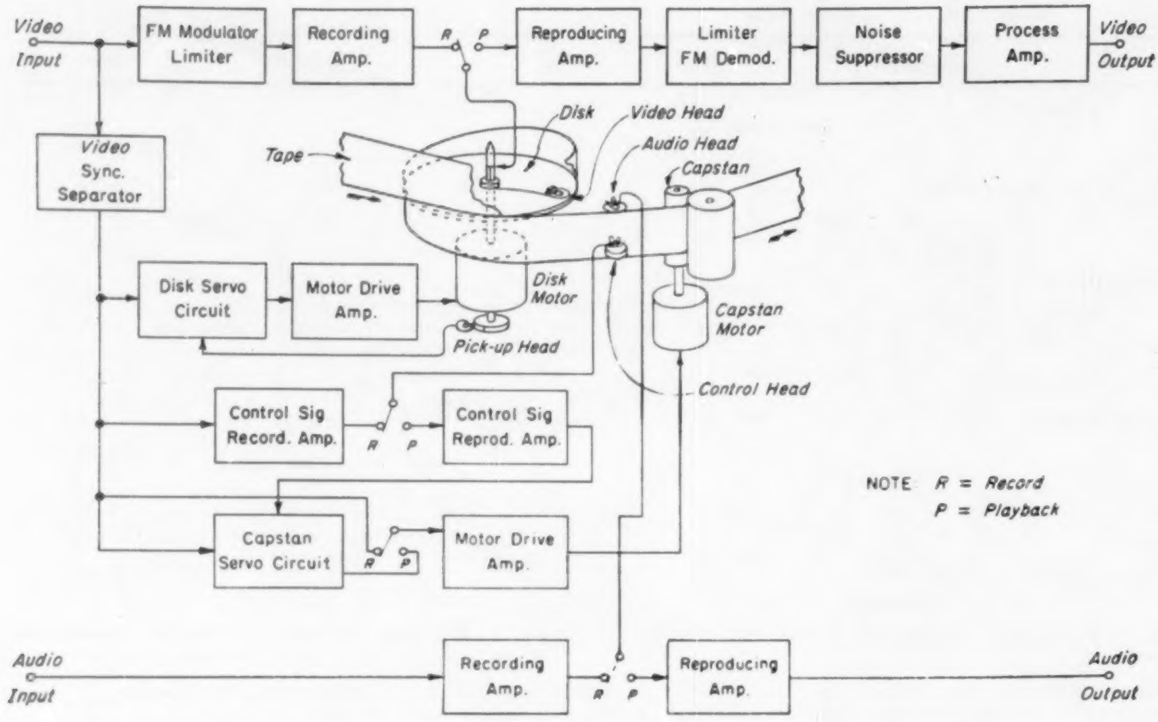


Fig. 6. Toshiba video-tape recording system.

dropouts are but a small fraction of those with the conventional system.

(4) At recording mode, the picture recorded on the tape can be monitored simultaneously by the monitor head.

(5) The new system can reproduce the picture at any tape speed, whether fast forward, slow forward, rewinding, or stopped. This greatly facilitates the effective montage or splicing of the tape.

The most important point, however, is that this system has remarkable advantages for NTSC color television because it is unnecessary to switch the video head in the middle of a picture.

Discussion

Loren L. Ryder (*Ryder Sound Services, Inc.*): Would you explain the manner of editing these films, the manner in which you cut the film to bring scenes together?

Dr. Sawazaki: We edit by monitoring the reproduced picture.

K. Blair Benson (*CBS Television Network*): One of your slides stated that dropouts were reduced by this system as compared to the conventional systems. Would you explain how this is brought about?

Dr. Sawazaki: Experimental results show that dropouts are greatly decreased in this system; this, we think, is mainly due to the mechanism. In this system, there is no mechanical support behind the tape. The head-to-tape contact is extremely smooth and there is no head switching as in the conventional system.

Mr. Benson: Can you estimate or give an approximate figure for signal-to-noise ratio of the system?

Dr. Sawazaki: The video signal-to-noise ratio is 35 db, and the audio signal-to-noise ratio is 45 db.

Howard Kirk (*KINTEL Electronics*): Did I understand correctly that you said you are able to obtain a picture reproduced at a still position or at a stop position of the tape?

Dr. Sawazaki: Yes, the new system can reproduce the picture at any tape speed. The tape, however, will wear out if you keep it stopped too long.

Mr. Kirk: Could you explain how a picture is obtained in that position or under these conditions, under a stop position?

Dr. Sawazaki: In this system one television field is recorded in one long track on the tape, so we can reproduce the picture at the stop position of the tape with the head disc rotating at 60 cycles, i.e., the field frequency of TV picture.

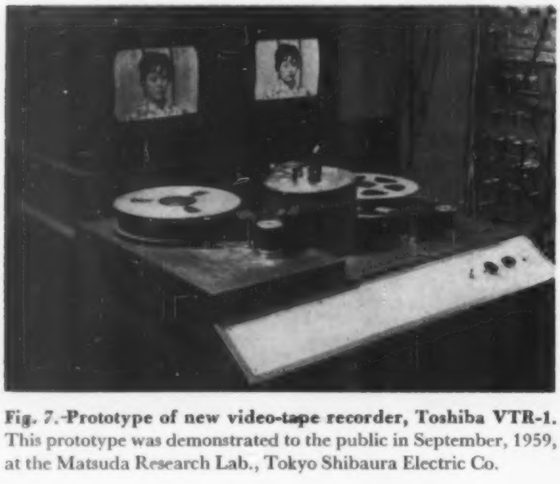


Fig. 7. Prototype of new video-tape recorder, Toshiba VTR-1. This prototype was demonstrated to the public in September, 1959, at the Matsuda Research Lab., Tokyo Shibaura Electric Co.

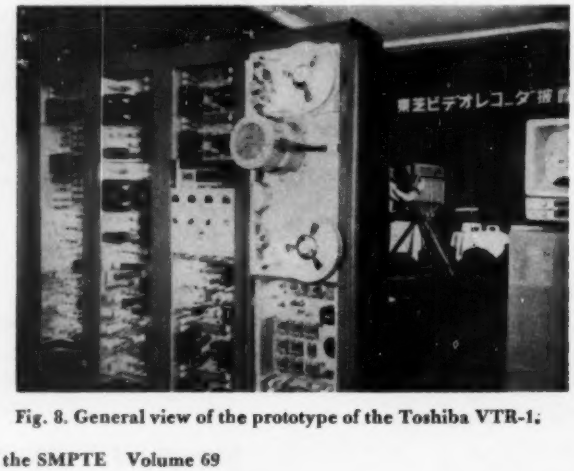


Fig. 8. General view of the prototype of the Toshiba VTR-1.

Alex Maxie (*Ampex Corp.*): It seems that the center-to-center track spacing is comparable to the Ampex or RCA machine, since the single-track width is something like 0.006 in. Do you think you will be able to have interchangeability with this type of machine, since the 0.006 in. represents half of the center-to-center track spacing?

Dr. Sawazaki: Mutual interchangeability with this system is better than that achieved with the conventional system.

Mr. Maxie: I can see where the longitudinal position of the tape is much less critical, but it appears that the lateral position of the tape is extremely critical and the contact of the head with the tape is not close enough to form evenly spaced slant tracks on the tape.

Dr. Sawazaki: Tape slides around the cylinders and the lateral position of the tape can be precisely controlled by the tape transport guides on the cylinders.

Col. Richard H. Ranger (*Rangertone, Inc.*): It should be noted that there is no deformity of the film in this process—in other words, the tape is not curved. This is definitely an advantage. I happen to know about this because we were once engaged in transoceanic transmission of pictures—single pictures. We used this system when I was with RCA in 1928. We used a drum and we had the films go around in that way, and we had one revolving head inside. We sent one picture at a time by that process in 1928. That's entirely photographic.

Donald C. McCroskey (*American Broadcasting Co. Hollywood*): What sort of head life do you get with an arrangement where one head does all the work as compared with the conventional system which has four heads sharing the friction?

Dr. Sawazaki: In our system, head life is about 30 to 50 hours but we can replace the head element easily and instantly.

Mr. McCroskey: It would seem that for this system to work there must be some sort of discontinuity as the head passes from the bottom of the top spiral to the top of the bottom spiral, yet I didn't see anything like that. It appeared to me that as the spiral passed over the head the path of the head had to go from the bottom of the tape to the top of the tape on the spirals. How do you avoid any interruption during this period?

Dr. Sawazaki: When a video head runs across the tape edges, the reproduced signal is instantly interrupted. But the interrupted time interval is very short, about 100 to 300 μsec. The phase of the interrupted time is controlled, in order to coincide with an appropriate phase in a vertical blanking interval. In a processing amplifier, the horizontal synchronizing pulses of this part are reinserted.

Mr. McCroskey: Is the tape butted together or is it slightly overlapped?

Dr. Sawazaki: In one system it is overlapped and in the other it is butted. We are experimenting with two systems.

Ralph Lovell (*NBC, Hollywood*): What, if any, experience have you had in splicing two separate scenes? I gather that you have made splices, and joined two scenes together.

Dr. Sawazaki: We have already experimented with the vertical cutting. As to the cutting parallel to the video tape, we are now designing a splicer for this purpose, and we expect to be able to cut and splice the tape effectively by this method.

Mr. Maxie: Must the tape be threaded from the end or is it possible to thread the machine with part of the tape on each reel, side loading?

Dr. Sawazaki: In the first prototype system it was difficult, but now with the new design we can thread from the side.

Development Determination by Infrared Densitometry

By RICHARD E. BURKHART and CONRAD A. STRUB

Infrared radiation has been utilized in many fields of investigation. The research presented here was performed to investigate the application of infrared densitometry as a feasible and valid method of development determination. An apparatus was modified to emit and detect infrared radiation. Partially processed films were metered by the application of infrared densitometry and an empirical formula was derived to calculate the corresponding fixed-out white-light densities. The D-log E curves were plotted from the calculated data and comparison studies were made with curves drawn in the conventional manner. When the calculated data were derived from an empirical power series formula, the resulting sensitometric data were agreeable within acceptable limits.

Several methods have been described in literature which evaluate partially processed photographic negatives by infrared scanning or densitometric techniques. In two methods the purpose is to control the variable-speed characteristics of high regression of inertia developer-emulsion combinations.[1,2] Such systems have "constant gamma" capabilities, and development may be continued to vary emulsion speed and thus in effect to correct for initial exposure error. Another method describes a system which continues development until a preset infrared density difference occurs between two exposed patches. This automatic gamma control is employed in the graphic arts industry.

All the methods mentioned appear to assume a linear relationship between the infrared densities of wet, unfixed samples and printing densities of fixed, dry samples. The authors of this paper suspected that a curvilinear relationship may be involved. From theorizing about the development process it may be seen that as metallic silver is forming in any given area, the silver halide is diminishing. The silver halide content has a significant attenuating effect on the infrared radiation.

It was decided to determine this relationship and test its consistency. This experiment was based around one emulsion-developer combination, and the resulting relationship should not be assumed to apply to other combinations.

If infrared densitometric techniques are to be employed to control the development process, some means of arresting the developer must be perfected. This arresting bath should be such that it immediately halts the development and yet can be neutralized by a buffer so that development may be continued after infrared density determinations have been made. It was not the purpose of this experiment to actually make application of continued development but only to demonstrate its feasibility.

Provision must be made to restrict the passband of the modified densitometer from the sensitivity region of the emulsion. This is best accomplished by heavy filtration of the radiation source. The upper limit is controlled by the response characteristics of the infrared receptor.

The ultimate objective of this experiment was to show that a mathematical expression could be derived whereby the final printing densities may be calculated for a sensitometric sample from its infrared densities. For a rapid solution of the calculations, the output signal of the amplifier could be fed to a properly programmed computer.

Experimental Procedure

The principal photographic materials used in this investigation consisted of a 35mm antihalationless panchromatic film (Kodak Plus X Aerecon). Exposures were made on a Kodak Model 101 Sensitometer at two levels. One exposure level was coded standard exposure A and the second was coded standard exposure B.* Standard exposure B was

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This senior research report was submitted on May 28, 1960, by Richard E. Burkhart and Conrad A. Strub to the College of Photography and Graphic Arts, Rochester Institute of Technology, Rochester, N.Y., as a requirement for the photographic course, Materials and Processes.
(The Society's Student Award was made to the authors for this paper on October 18, 1960, at Washington, D.C.)

* See Appendix.

ultimately chosen for use in the experimentation.

Development was carried out in Kodak D-76 Developer at 20 C with ASA standard tray agitation. Each development run consisted of three exposed film strips. One strip, the control, was processed for 10 min. The second and third strips were processed for a specified time and then placed in the arresting bath.* Strips 2 and 3 were then squeezed between rubber blades and placed on an infrared densitometer for reading. After the infrared readings had been obtained, strip 2 was placed in the fix bath (Kodak Fixing Bath F-5). Strip 3 was then placed in the buffer bath and subsequently returned to the original developer for a period of time to total 10 min development.* Development interruptions were investigated after 2, 4 and 6 min of basic development, respectively. All development was carried out in a temperature control sink to minimize variations. It is undoubtedly obvious to the reader that all the infrared readings were obtained in total darkness.

The three strips were then read on a white-light densitometer. The white-light densities were plotted against their respective infrared densities. Strips 1 and 3, both being processed for a total of 10 min, were then compared to determine the effects of the interrupted processing.

The accumulated and plotted data were evaluated by three independent methods. It was first assumed that the data described a segment of a circle. By mechanical means the best fitting curve was scribed and calculations were made graphically. A second approach was that of applying the data to the mathetical requirements of the general formula for the solution of conics. After the derivation of a standard conic formula, the data were tested by calculating white-light densities from infrared densities chosen at random. The last approach to correlating the data was to apply them to a power series and derive a basic equation which would lend itself to rapid and accurate solution.

Results

In a preliminary investigation it was found that the reduction of applied voltage to the densitometer light box greatly decreased the visible light output without an objectionable loss in infrared radiation. The use of two Kodak Wratten 87C Filters adequately restricted the radiation in the densitometer to wavelengths above that which would produce fogging with the photographic film used.

An arresting bath of 0.33 normal was sufficiently concentrated to prevent continued development during the infrared readings.

Passing the partially processed films between two rubber blades reduced the water content to a concentration which enabled reproducible results in repeated infrared readings.

The mechanical and graphical application of the accumulated data proved to be a satisfactory solution of output densities when the input infrared densities were above 0.9, below which highly varied results are obtained. The results again began to vary to a significant degree as we approached the maximum densities which were obtainable with our apparatus.

The data, when applied to the general formula for conics, described an ellipse. The standard formula for the ellipse, when applied to our data, proved to be satisfactory over an infrared density range of 1.0 to 3.0, above and below which it was completely unsuccessful owing to the derivation of imaginary values. An explanation for this mathematical phenomenon was unobtainable.

The mathematical utilization of the power series proved to be the most satisfactory of the three evaluation methods. The use of a formula containing six coefficients and values of input raised from zero to the fifth power enabled the calculation of white-light densities from randomly chosen infrared densities with acceptable accuracy.

Discussion

As previously noted, the infrared density determination necessitated darkroom operation. This required a means of registering each step of the sensitometric sample with the densitometer aperture. Registration pins were installed on the sensitometer head and corresponded to a click-stop guide mechanism affixed to the densitometer light box.[3] Data readout was accomplished by the observer viewing the hooded illuminated amplifier dial and orally recording the successive densities on an office dictating machine. This system was in lieu of an automatic recording device.

Control of the densitometer was maintained within narrow limits. Three selected density levels of a standard step tablet were metered at each laboratory session and at no time during the period of investigation did the instrument deviate radically from the mean.

The function of each three-strip test was twofold. First, it provided a comparison between noninterrupted and interrupted development. The conclusion that the arresting and buffer solutions provide for a satisfactory system of interrupted development was based on the results of six pairs of samples. Since the developing agents in Kodak D-76 are virtually inactive at low pH levels, the arresting bath is merely a strong acid stop bath. A rapid reduction of emulsion pH halts the development process with minimum delay. With the residual developing agents inactive, staining due to aerial oxidation is eliminated. Rather than depend on prolonged washing to neutralize any residual acid prior to continued development, an alkaline buffer is employed. Its pH approximates that of the developer.

Secondly, the three strips provided a means of comparing infrared densities of partially processed materials with white-light densities read from completely processed films.

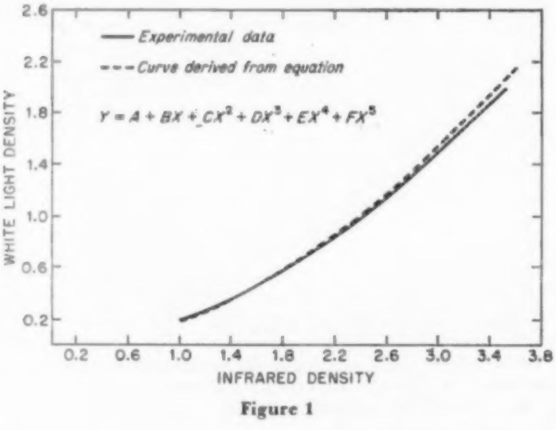

Figure 1

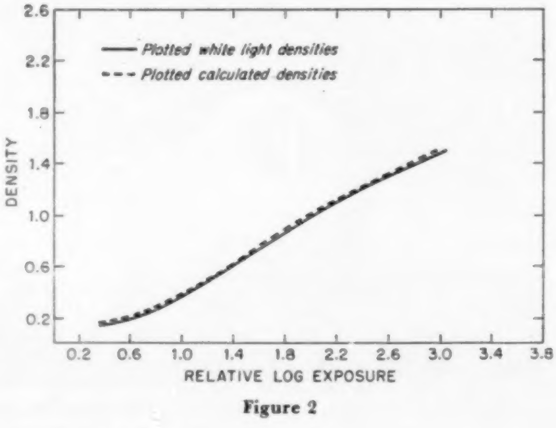

Figure 2

Determination of the mathematical expression was first attempted graphically by locating the center of the circle that best described the data. The general equation for a displaced circle is:

$$(X - H)^2 + (Y - K)^2 = R^2$$

Re-equating to solve for Y gives

$$Y = -\sqrt{R^2 - (X - H)} + K$$

where X is the infrared density input and Y is the printing density output.

Upon inscribing this circle on the data, it was soon noted that no one arc could satisfy the regression. On the assumption that the data might conform to another conic section, the general equation for conics was applied, this being in the form:

$$Y = AX^2 + BXY + CY^2 + DX + EY + F$$

The data were broken up into six groups and the mean X and Y values for each were calculated. A matrix of six equations in six unknowns was thus obtained. Derivation of the six constants was facilitated by application of an IBM-705 Computer. Re-equating to solve for Y necessitated use of the quadratic,

$$Y = \frac{-(BX + E) \pm \sqrt{(BX + E)^2 - 4C(AX^2 + DX + F}}{2C}$$

Owing to the complexity of this equation, an alternate method was proposed which would provide simpler calculations. This method does not assume a conic. By utilizing the same six average X and Y values, a power series was derived in the form

$$Y = A + BX + CX^2 + DX^3 + EX^4 + FX^5$$

A matrix of six equations in six unknowns was again prepared.

Figure 1 illustrates the curvilinear relationship between infrared densities and blue-light densities. The curve is plotted by means of the six average X and Y values.

Conclusions

Although this experiment did not lend itself to statistical evaluation, it must be understood that confidence limits are to be attached to any calculated density. Empirical evaluation of the original scatter diagram and of comparison curves plotted from calculated densities suggest that these limits be set at ± 0.04 density units. By referring to Figs. 2 and 3, the close agreement between the actual white-light density and calculated density will be noted. These samples did not contribute to the derivation of the regression and power series equation constants.

The fact that an equation of the fifth power best fits the experimental data is an indication of the complex nature of the silver halide-metallic silver relationships. The authors of this paper in no way imply that there exists a simple relationship.

APPENDIX

A. Equipment

Sensitometer: Kodak Model 101.
Densitometer: Welsh Densichron.

1. Infrared modifications:
   (a) Insertion of two 87C Wratten gelatin filters in light path.
   (b) Removal of the heat-absorbing glass.
   (c) Reduction of the lamp voltage.
   (d) Use of S-1 surfaced vacuum phototube receptor (silver-oxygen cesium).
2. White-light (printing) densities:
   (a) Unmodified light box.
   (b) Use of S-4 surfaced vacuum phototube (antimony-cesium).

Exposure of samples:
Standard exposure A; first step, log E = 1.20.
Standard exposure B; first step, log E = 1.00.

B. Solutions

Developer: Kodak formula, D-76 at pH = 8.1–8.3.
Arresting bath: 2% acetic acid (0.33 normal), pH = 2.5.
Buffer: 0.01 molar borax solution, 3.8 g/l, pH = 9–9.5.
Fixing bath: Kodak formula F-5.

C. Constants for Mathematical Expressions

1. Circle (displaced): $H = -2.7$, $K = 8.0$ and $R = 8.6$.
2. Conic general equation: $A = 0.711$, $B = -2.039$, $C = 1.516$, $D = -1.089$, $E = 1.470$ and $F = 0.430$.
3. Power series: $A = -0.8283$, $B = 2.3585$, $C = -2.3098$, $D = 1.2552$, $E = -0.3029$ and $F = 0.0277$.

Acknowledgments

The authors are indebted to Professors Hollis Todd and Albett Rickimers, College of Photography and Graphic Arts, Professor Castle Foard, College of Applied Science, and Robert Malack, Eastman Kodak Co., for their cooperation and suggestions.

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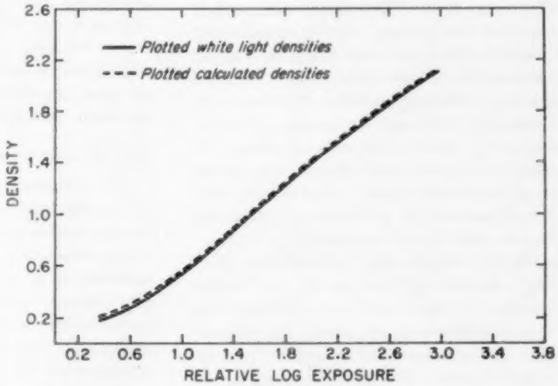

Figure 3

Techniques in Color Duplication

By ROBERT O. GALE and WALTER I. KISNER

The production of black-and-white and color master positives and color duplicate negatives which lead to a final print quality comparable to that obtained in a print made from the original negative is a difficult problem for the motion picture laboratory. This paper is intended to provide a better understanding of the proper techniques and to point out some of the pitfalls in color duplication operations for laboratory technicians engaged in this work. The requirements for good master positives and color duplicate negatives and the techniques for achieving optimum quality are discussed. As a practical guide, step procedures for producing master positives and duplicate negatives through different film systems are outlined.

INTRODUCTION

Over the past decade, outstanding progress has been made by the industry in the production of motion pictures in color. Of the many pictures released, numerous examples can be cited which demonstrate that a high level of photographic quality can be and is being achieved. This observation has made the industry ever more quality-conscious. However, it must be evident that a high level of quality can be attained only through the combined efforts of a great many different groups of people. A major portion of this reponsibility rests with the laboratory, not only in matters pertaining to processing of various films but also in the skill and care in preparing duplicates and release prints. It behooves the laboratory to utilize every available tool to meet this responsibility.

While duplicating procedures have been successfully employed by the industry for many years in black-and-white motion-picture production, the translation of this know-how to color work has not been easy. Color duplicating operations introduce a number of complexities which are not encountered in black-and-white work. Although the basic principles pertaining to color duplication have been stated in earlier papers,[1,2,3] there is evidence to show that they have often been overlooked and that improper techniques have been used in many cases, resulting in a loss of quality.

It is felt that a restatement of the principles underlying good color duplicating techniques and a step-by-step outline of the procedures applicable to existing materials and systems would be helpful to laboratories in their efforts to obtain the best quality. This paper is especially intended to assist those laboratories that have only recently become engaged in color duplicating work. It should also serve those laboratories having more extensive experience as a valuable reference and guide in carrying out such operations and particularly in training new laboratory control personnel.

Three duplicating systems will be described and the recommended techniques and step-by-step procedure for each will be given. These are systems for producing master positives (either black-and-white or color), color duplicate negatives and color internegatives (from color reversal originals). An attempt will be made to explain the importance of using the correct methods to achieve optimum quality.

The Necessity for Duplicating Steps

The reasons for duplicating operations in motion-picture production are well known and can be summarized briefly: (1) a finished production requires a number of special effects such as fades, lap dissolves and wipes, which are most conveniently made by using duplicating steps; (2) duplicate negatives may be required as insurance against total loss of the valuable camera original because of abrasion, fading of dyes, or other damage caused by improper storage; (3) duplicate negatives are frequently needed for shipment abroad for foreign release printing; (4) reduced or enlarged duplicate negatives are required when the camera original is larger or smaller than the final release print; and (5) in making 16mm prints from color reversal originals, the preparation of color internegatives offers economic advantages when larger quantities of prints are desired in comparison with making prints on another reversal film.

Desirable Attributes of Duplicate Negatives

It should be obvious that a duplicate negative is only a means to an end. The major requirement of a duplicate negative is that it have characteristics suitable for giving prints whose quality level is as close as possible to that obtained in prints made from the original negative. More specifically, this means that the tonal gradation, overall contrast, hue and saturation of the colors, definition and graininess of the print made from the duplicate negative be as close as possible to that obtained in a direct print.

A common misconception is that a duplicate negative should appear visually and densitometrically like the original negative. Although this would be very desirable for a number of reasons, the materials used in the duplicating operations impose certain limitations which make it impossible to achieve. As a consequence, when original negatives are intercut with duplicate negatives, adjustments of the printer light intensity and color balance must usually be made during release printing to give satisfactory prints from each. Obviously, the required changes must be within the range of light intensity and color balance adjustments available in the printer to be used while still allowing normal scene-to-scene corrections to be made. It is desirable that these provisions be met without loss of quality or increased costs.

From the physical standpoint, a further requirement is that a processed duplicate negative have good stability in order to be an adequate substitute for the original negative. It is assumed, of course, that proper storage facilities with correct temperature and relative humidity and freedom from contamination are provided. It is also assumed that recommended cleaning and rewashing techniques be employed in order to prevent any changes in the dye images.

Some Problems in Duplication

In duplicating work there are a number of considerations leading to situations that contribute to inferior quality. One of the major problems for the laboratory is the constant endeavor to reduce the costs of operation. For example, it may be less time-consuming and less costly for a laboratory to operate its printers at the same balance as used for printing an original negative. Correctly exposed duplicate negatives, however, will have higher picture densities than the original negative and will require increased printer exposure and some color timing changes. A duplicate negative that has been made to print at the same intensity level as the original negative may produce serious tone compression.

Presently available duplicating materials have a rather low inherent sensitivity, a property which, in the light of present emulsion technology, seems to be inevitable where good definition and minimum graininess are requisite. Because of this fact, the printer illumination level and speed must be appropriate to obtain correct exposure of the duplicating film. Also, in cases where the printer light intensity is marginal, a problem

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(This paper was received on August 1, 1960.)

may exist in release printing since it would be necessary to reduce the speed of the printer for printing the duplicate negative portion of the intercut footage without actually stopping the printer to effect the change in speed. A practical method of accomplishing this has been described in a previous paper by Graham and Ott.[4]

A certain amount of variation between different emulsion numbers of duplicating materials as well as variations in the process and printer may introduce some problems, especially when a color duplicating film is used for making both color master positives and color duplicate negatives. This situation calls for careful testing of raw stock and strict control of process and printer variables to prevent losses in quality of duplicates. While some of the variables may be compensated by changes in printing conditions, one cannot rely too heavily on this method of correcting for large errors.

Everyone recognizes the fact that to do a job well, he must have the proper tools and know-how to handle them. In duplicating work, an essential tool is sensitometry. Each member of the control staff must have at his disposal the necessary equipment for making sensitometric tests, a thorough understanding of the methods used, and the ability to interpret the results correctly. Proper training of all control personnel in the use of sensitometric methods is a problem with which each laboratory must deal. A training program represents a sound investment which will yield good returns in the way of higher quality.

Sensitometric Equipment

Sensitometric control strips are used to determine the required gamma for black-and-white master positives and to monitor the color processes involved in the duplicating system to be used. An intensity-scale sensitometer having an intensity level and exposure time close to the conditions used in the printer is preferred. If a sensitometer is not available, it is possible to employ a printer with proper control so that it will serve as a sensitometer as described in a previous paper.[5]

Silver or carbon step tablets having a density range of 3.00 and density increments between steps of 0.15 (21 steps) or 0.30 (11 steps) are most satisfactory for use in duplicating work.*

Any one of a number of commercially available photoelectric color densitometers is satisfactory for measurement of the densities of black-and-white or color master positives and color duplicate negatives. Such instruments should be preferably equipped with narrow-band filters† of a type which approximates the printing densities of the color films being measured.

To obtain optimum tone reproduction it is requisite that the printers used can provide correct exposure levels. The importance of correct exposure level will be emphasized in this paper. The printer conditions for each duplicating step in our laboratory are outlined in the Appendix.

Table 1. Color duplicating systems.

I	II	III
Color Negative Original (65mm or 35mm)	Color Negative Original (65mm or 35mm)	Reversal Color Original (Kodachrome or Ektachrome Commercial)
Black-and-White Master Positive: Red, Green, Blue	Color Master Positive	Color Internegative (35mm or 16mm)
Color Duplicate Negative (35mm or 16mm)	Color Duplicate Negative (35mm or 16mm)	Release Print (35mm or 16mm)
Release Print (35mm or 16mm)	Release Print (35mm or 16mm)	

Duplicating Systems

This paper is concerned with three systems of duplication, shown diagrammatically in Table I. They represent the systems currently in use by laboratories when working from either color negative or color reversal originals.

In the first system, black-and-white separation positives are made from the color negative original, and these master positives are then printed in register onto a multilayer color film to give the color duplicate negative. This system has the advantage of providing a more or less permanent record of the valuable original because of the good keeping characteristics of processed black-and-white films. Black-and-white master positives also offer the advantage of good gamma control when certain compensations must be made for possible variations in the system.

The second system employs a multilayer color film for preparation of both color master positives and color duplicate negatives. This procedure is much less time-consuming than the first method and also eliminates the need for a registering-type printer. However, it does possess the disadvantage that dye fading can occur, especially if the processed color films are stored under adverse conditions or if they have not been processed correctly. Proper removal of residual hypo and correct stabilization treatment are essential to retard changes in the dye images. For long-time storage, therefore, black-and-white separations should still be made for protection purposes.

The third system involves preparation of a color internegative on a multilayer color film from a reversal color original. This method is especially useful where larger numbers of release prints are wanted and a reversal printing system would be considered too expensive, or in places where reversal print processing facilities are not available, or finally, where it is desired to have release prints of smaller or larger size.

In using any of these systems, the basic rule for making master positives (either black-and-white or color), color duplicate negatives and color internegatives is the same as that applied to monochrome duplicating work — namely, to use only the straight-line portion of the characteristic curves of the duplicating films involved. This procedure assures that optimum tone reproduction will be obtained; in other words, a one-to-one transfer of the tonal values of the original will be effected.

Unfortunately, presently available color duplicating materials do not give curves that are ideal in all respects. The straight-line regions are usually quite limited and, in some cases, the materials do not exhibit a true straight-line region. Further, the separate curves for exposure of the material to red, green and blue light, respectively, may not show either straight-line portions of the same length or toe and shoulder regions having exactly the same shape. Normal emulsion and processing variations can further complicate matters. These factors emphasize the importance of careful placement of the scene at the proper position on each curve so as to utilize as much of the linear portion as possible. In the case of scenes having a wide density range, some compromises may have to be adopted and some judgment is needed in order to place the most significant picture detail on the linear part of the curves. Some examples to illustrate correct placement of the scene on the curves are given in this paper.

SYSTEM I — Employing Black-and-White Master Positives

A. Preparation of Time-Gamma Curves for Master Positives

The initial step in the system utilizing black-and-white master positives is to prepare the time-gamma curves for the

* Another useful tablet is a four-step tablet made on Eastman Color Negative Film, Type 5248 or Type 5250 available from the Motion Picture Film Dept., Eastman Kodak Co. This tablet covers the full density range from white to black encountered in the picture negative.

† Such as the "Status K" filters furnished for use with the Eastman Electronic Densitometer, Type 31A.

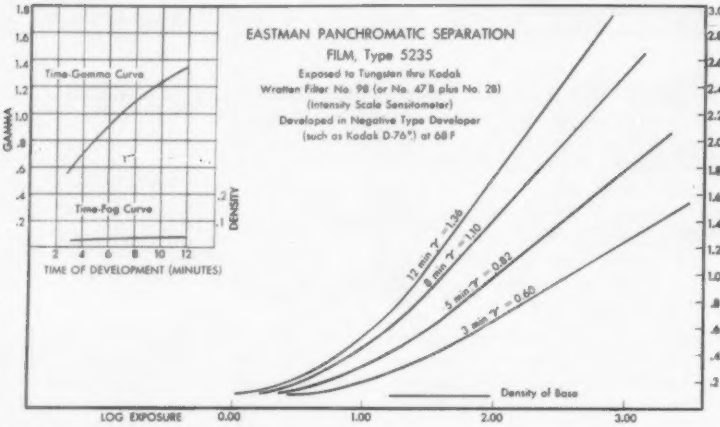

Figure 1a.

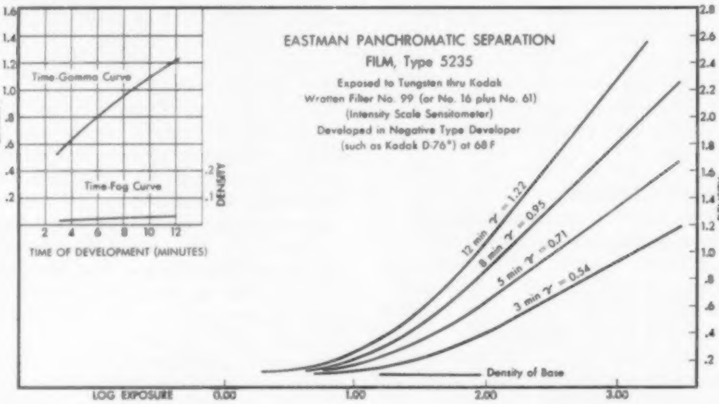

Figure 1b.

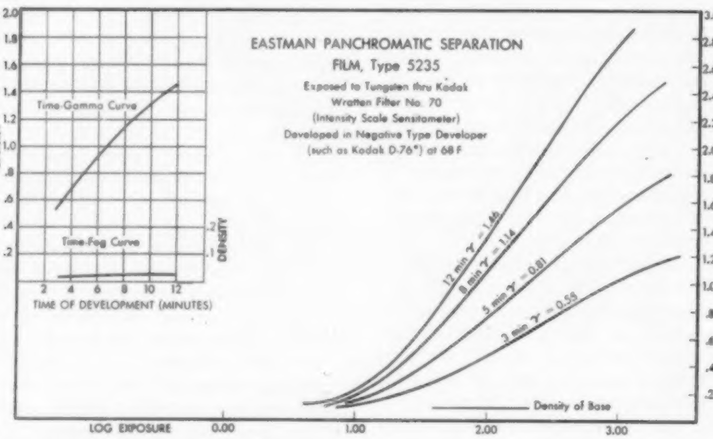

Figure 1c.

Fig. 1a-c. Families of D-log *E* curves and time-gamma curves for Eastman Panchromatic Separation Film, Type 5235.

material being used. A set of sensitometric control strips is exposed using the same intensity level and filters as would be used in printing picture material. The strips are processed for a series of times in the equipment regularly employed for processing picture footage.

The densities of the strips are measured and the corresponding characteristic curves for exposure to blue, green and red light are plotted. A typical set of curves for Eastman Panchromatic Separation Film, Type 5235 is shown in Figs. 1a, 1b and 1c. The gamma value for each curve is determined and time-gamma curves are also plotted as illustrated. These time-gamma curves are used later in the procedure to permit choice of the appropriate development time for a specified gamma.

B. Preparation of Printer Test Loop

For the first trials it is desirable to duplicate only a short length of color negative original. It is most convenient to prepare a printer test loop consisting of a processed color negative sensitometric strip and a few frames of the scenes to be duplicated.

C. Determination of Master Positive Control Gammas

In the usual case, it will be desired that the color duplicate negative have the same contrast characteristics with respect to the print film as the original negative. This means that the overall gamma of the duplicating step should be equal to unity. If γ_{SP} represents the gamma of the particular separation positive and γ_{DN} represents the gamma of the color duplicate negative, then

$$\gamma_{SP} \times \gamma_{DN} = 1$$

Since γ_{DN} is fixed by the particular emulsion number of color duplicating negative material being used and the processing thereof, we can determine the correct gamma for each of the separation positives by the relationships:

$$\gamma_{SP\ (blue)} = \frac{1}{\gamma_{DN(blue)}}$$

$$\gamma_{SP\ (green)} = \frac{1}{\gamma_{DN\ (green)}}$$

$$\gamma_{SP\ (red)} = \frac{1}{\gamma_{DN\ (red)}}$$

In practice, these equations have to be modified further because the print-through gammas of the separation positives are not the same as would be predicted on the basis of the integral densitometer measurements. In other words, there is a printing factor (P_B, P_G and P_R) associated with each of the separations when printing onto the color duplicating negative film. The above equations then become:

$$\gamma_{SP\ (blue)} = \frac{1}{P_B\ \gamma_{DN\ (blue)}}$$

$$\gamma_{SP\ (green)} = \frac{1}{P_G\ \gamma_{DN\ (green)}}$$

$$\gamma_{SP\ (red)} = \frac{1}{P_R\ \gamma_{DN\ (red)}}$$

Initially, it is most convenient to assume that P_B, P_G and P_R are each equal to 1 until a more precise determination can be made later in the procedure.

The step-by-step determination of the required control gammas for the separation positives can therefore be stated as follows:

Step 1. Obtain a sensitometric control strip for the original color negative process (for example, on Eastman Color Negative Film, Type 5248, or Type 5250, processed according to the manufacturer's recommendations).

Step 2. Measure the integral densities of the steps of the control strip obtained in Step 1, to blue, green and red light

and plot the corresponding characteristic curves. See Fig. 2. These curves will be used later on.

Step 3. Obtain a sensitometric control strip for the color duplicate negative process (for example, on Eastman Color Intermediate Film, Type 5253 processed according to the manufacturer's recommendations).

Step 4. Measure the integral densities of the steps of the control strip obtained in Step 3 to blue, green and red light and plot the curves. See Fig. 3.

Step 5. Measure the gammas of the curves obtained in Step 4. In the example shown in Fig. 3, the values are:

$$\gamma_{DN\ (blue)} = 1.07$$

$$\gamma_{DN\ (green)} = 1.03$$

$$\gamma_{DN\ (red)} = 0.94$$

Step 6. Calculate the reciprocals of the gammas obtained in Step 5, as follows:

$$\gamma_{SP\ (blue)} = \frac{1}{1.07} = 0.93$$

$$\gamma_{SP\ (green)} = \frac{1}{1.03} = 0.97$$

$$\gamma_{SP\ (red)} = \frac{1}{0.94} = 1.06$$

These are the *temporary* gamma values for the separation positives, as explained earlier, and they will be corrected later on when the exact printing factors are determined.

D. Preparation of Master Positives

We are now ready to proceed with actual printing of our test loop con:a.n-ing the original color negative sensitometric strip and frames of typical scenes. The step-by-step procedure is as follows:

Step 1. Print the test loop onto the master positive material, as for example Eastman Panchromatic Separation Film, Type 5235 (see Appendix for printer conditions).

Step 2. Expose sensitometric control strips on the master positive material under conditions approximating those used for printing.

Step 3. Process the printed footage and control strips for a time sufficient to give the gamma values previously calculated.

Step 4. Measure the highest and lowest integral densities (to blue, green and red light) of the original picture negative, using a 1-mm densitometer aperture, and plot these values on the negative control curve. The step number of the control strip for which the densities are closest to the picture densities should also be noted and marked on the control curve (see Fig. 2). The highest and lowest picture densities of the camera negative plotted in Fig. 2 are closest to Steps 5 and 16 on the negative control curve. The red, green and blue integral densities of steps 5 and 16 of the negative control curve are tabulated in Fig. 2.

These are reference points, and the same steps should be measured and plotted on the control curves in each duplicating step. It is important that these steps plot on the straight-line portion of the control curves for the master positive and duplicate negative. If they do not, exposure of the materials must be adjusted.

A further word of explanation is in order with respect to the reference points, which define what will subsequently be referred to as the *picture density range*. After some experience in color duplicating work, it soon becomes evident that print-through curves do not exhibit well-defined straight-line regions, and it is difficult in many cases to draw a reasonable straight line whose slope (gamma) will have the proper significance relative to tone reproduction. The use of the reference points avoids the necessity for plotting print-through curves and measurement of gamma values. The control curves for the various materials do, however, exhibit reasonably good straight-line regions and, when the reference points are plotted on these curves, one is then able to ascertain whether exposure levels are correct.

Step 5. Plot the picture density range (Steps 5 and 16) of each of the three master positives on their respective control curves (see Figs. 4, 5 and 6).

Step 6. Adjust the printing levels until the picture density range is placed properly on the straight-line region of the master positive control curves.

If the picture density range plots too low on the control curve, the exposure must be increased, i.e., if the picture density is 0.30 log E below the straight-line portion, 0.30 neutral density should be removed from the filter pack.

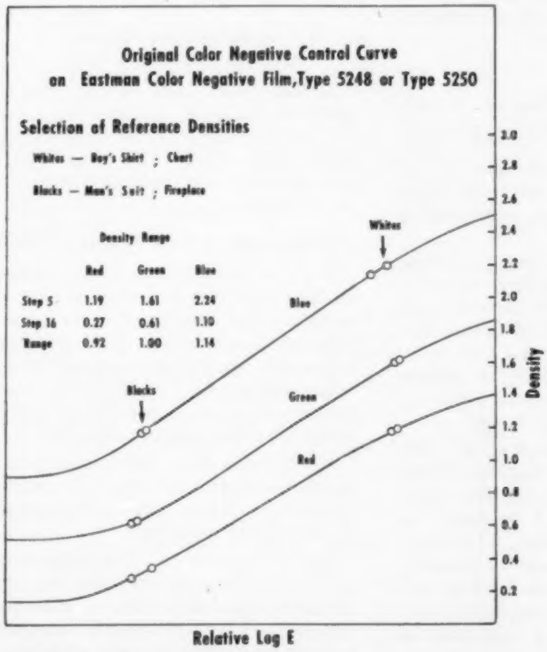

Fig. 2. Control Curve for original color negative.

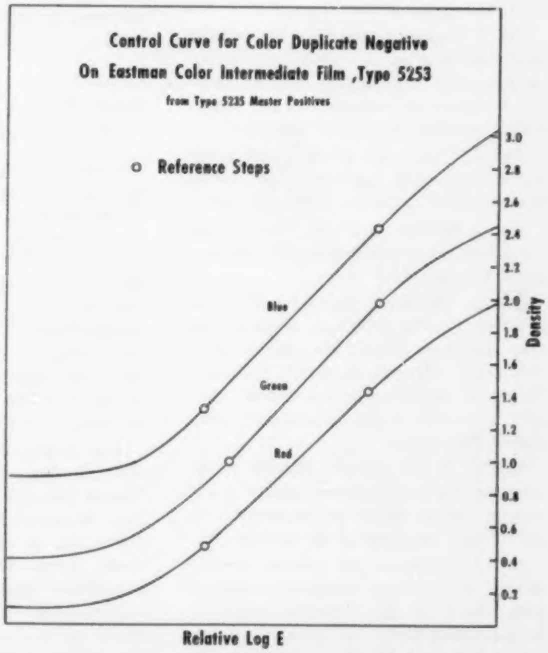

Fig. 3. Control curve for color duplicate negative with densities of reference steps, as printed from Type 5235 master positive.

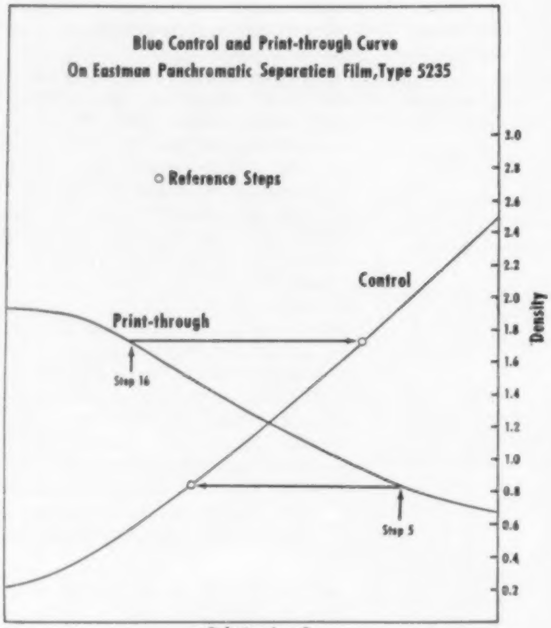

Fig. 4. Control and print-through curves for blue separation positive with reference steps.

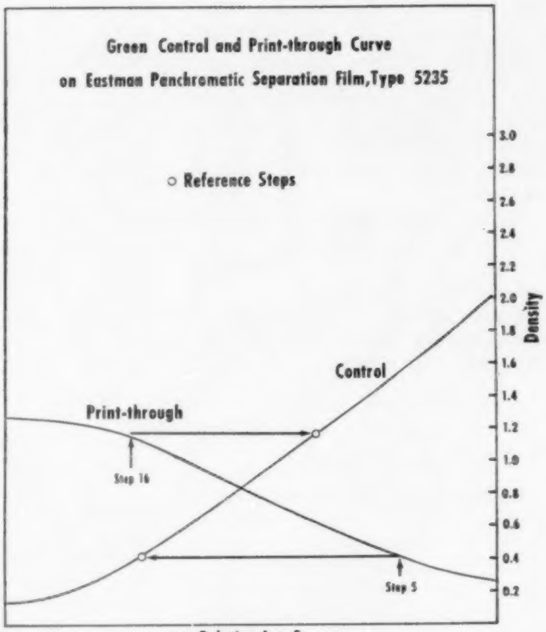

Fig. 5. Control and print-through curves for green separation positive with reference steps.

E. Preparation of Color Duplicate Negative

Step 1. Using a registering-type step printer, print the blue, green and red master positive gray scale strips (print-through strips) onto the color duplicating negative film. The printing conditions for carrying out this step using Eastman Color Intermediate Film, Type 5253, are given in the Appendix.

Step 2. Expose a sensitometric control strip from a silver or carbon step tablet on the color duplicating negative material using an exposure time which closely matches the printer exposure.

Step 3. Process the printed gray scale and control strip together according to the manufacturer's recommendations.

Step 4. Measure and plot the integral color densities of the control strip to blue, green and red light.

Step 5. Measure the integral color densities of the reference steps of the gray scale and place these on the curve obtained in Step 4. Figure 3 illustrates the ideal condition wherein the reference steps fall at the appropriate position on the curves.

Step 6. If the picture density range does not fall on the linear portion of the control curves, adjust the exposure level accordingly and repeat the procedure.

Step 7. Compare the picture density ranges of the color duplicate negative with those of the original negative. In all probability, the picture density ranges will not be the same, and this means that the separation positives have printing factors which must be taken into account. If the picture density range of the color duplicate negative is greater than that of the original negative, it will be necessary to use a master positive of lower gamma to correct the situation. If the picture density range of the color duplicate negative is less than that of the original negative, a master positive of higher gamma will be needed. The printing factors, $P_{,B}$ P_G and $P_{,R}$ can therefore be determined by the relationship:

$$P_{B,G,R} = \frac{\textit{Density Range of Color Duplicate Negative}}{\textit{Density Range of Original Negative}}$$

The gamma values of the three separation positives are then corrected simply by multiplying by their corresponding printing factors.

It should be noted that the printing factors associated with a given combination of printer and densitometer will remain valid for future duplication work with the same type of film. However, any changes in either the printer or densitometer will require a redetermination of the printing factors.

Step 8. Repeat the steps under "System I—Employing Black-and-White Master Positives," applying the correction factors determined in Step 7 to obtain the correct gammas and development times. Since printing exposure levels have been established, the picture original may now be duplicated. As a check on the processing conditions for the master positives, sensitometric control strips should be included with the footage.

Step 9. Repeat the steps under "Preparation of Color Duplicate Negative." Again, include sensitometric control strips as a check on the processing of the color duplicate negative. The density ranges of the color duplicate negative should now closely match those of the original negative.

SYSTEM II

Employing Color Materials for Both Duplicating Stages

In this system, both the color master positives and color duplicate negatives are made on Eastman Color Intermediate Film, Type 5253. The step-by-step procedures for each stage of duplication are as follows:

A. Preparation of Color Master Positives

Step 1. Monitor and adjust the process for Eastman Color Intermediate Film to be certain that it conforms to the manufacturer's specifications. This is highly important since any photographic variations from standard noted in the color master positive stage will be multiplied in the color duplicate negative stage.

Step 2. Prepare a printer test loop containing an original color negative control strip and, if possible, frames of the scene or scenes to be duplicated.

Step 3. Measure the integral densities to blue, green and red light for the negative control strip. Also, measure the highest and lowest integral densities in the picture area of the selected frames.

Step 4. Plot the characteristic curves for the negative control strip and designate

the steps whose densities correspond with the highest and lowest densities of the picture area. These will be the reference points throughout the duplication procedure and represent the picture density range which must be reproduced (refer to Fig. 2).

Step 5. Print the test loop onto Color Intermediate Film, Type 5253 using a contact printer. A step printer is preferred for obtaining maximum steadiness. See Appendix for printer conditions.

Step 6. Expose a sensitometric control strip on Color Intermediate Film, Type 5253, under conditions closely matching those used in the printer.

Step 7. Process the printed test loop footage and control strip together in a standard process.

Step 8. Measure all of the integral densities to blue, green and red light of the control strip and the corresponding densities of the reference steps of the printed strip.

Step 9. Plot the characteristic curves for the control strip and locate the positions where the densities of the reference steps of the printed scale occur on these curves. See Fig. 7.

Step 10. If the picture density range does not fall on the linear portion of the sensitometric control curve, the printer exposure must be adjusted. If exposure adjustments are needed for all three curves, removal or addition of neutral densities from the filter pack or adjustment of the printer light setting is called for. If exposure adjustments are needed for the individual blue, green and red curves, the filter pack must be modified by removal or addition of yellow, magenta or cyan filters, respectively.

Step 11. When the optimum printing level has been established print the original negative picture footage and negative control strip onto the Color Intermediate Film.

Step 12. Expose another control strip on Color Intermediate Film.

Step 13. Process the printing footage and control strip together.

Step 14. Measure the densities of the control strip and reference steps of the print-through scale.

Step 15. Plot the curves for the final sensitometric control strip and mark the positions for the densities of the reference steps of the print-through strip. This serves as a final check to see that no printing or processing errors have occurred.

B. Preparation of Color Duplicate Negative

Step 1. Expose a sensitometric control strip made on Color Intermediate Film, Type 5253 under conditions which closely match the printing conditions.

Step 2. Print the color master positive (correctly exposed print-through, Part A, Step 11) onto the Color Intermediate Film. A step printer of either the contact or optical type should be used at this stage (see Appendix).

Step 3. Process the control strip and print-through in a normal process for Color Intermediate Film.

Step 4. Measure the integral densities to blue, green and red light of all steps of the control strip and the reference steps of the printed scale.

Step 5. Plot the characteristic curves for the control strip and locate the positions where the densities of the reference steps of the print-through plot on these curves (see Fig. 8).

Step 6. If the picture density range does not plot on the linear portion of the control curve, the printer exposure should be adjusted.

Step 7. When the optimum printing level has been established, print the master positive picture footage and gray scale onto Color Intermediate Film, Type 5253.

Step 8. Expose a sensitometric control strip on Type 5253.

Step 9. Process the picture footage and control strip together in a normal process for Type 5253.

Step 10. Read the integral densities of the control strips and those for the reference steps of the print-through scale as before.

Step 11. Plot the curves for the control strip and locate the positions for the density values of the reference steps of the print-through scale. This serves as a final check to see that no errors have occurred in printing or processing of the color duplicate negative.

SYSTEM III

Making Color Internegatives From Reversal Color Originals

In this system, we have to deal with only one duplication stage. As a consequence, the only ways in which we can

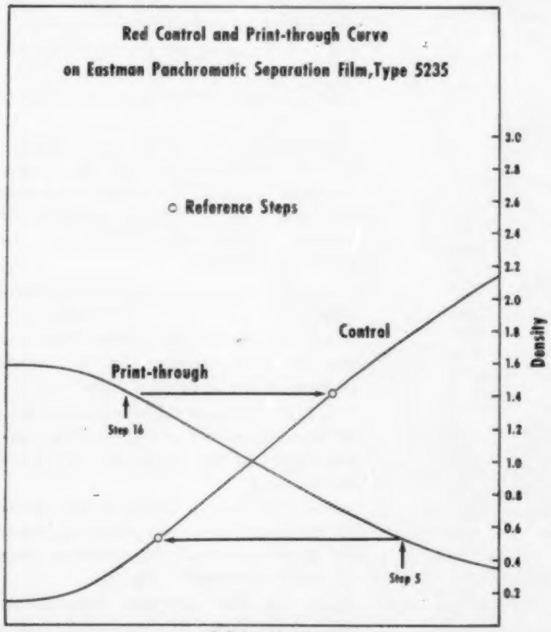

Fig. 6. Control and print-through curves for red separation positive with reference steps.

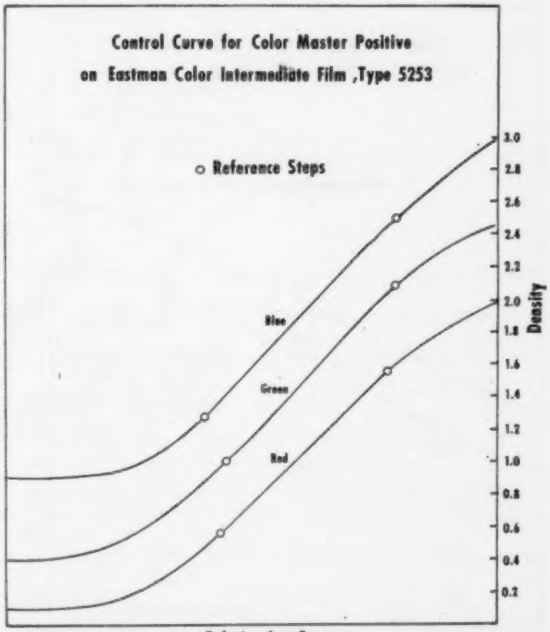

Fig. 7. Control curve for color master positive with densities from reference steps, as printed from original negative.

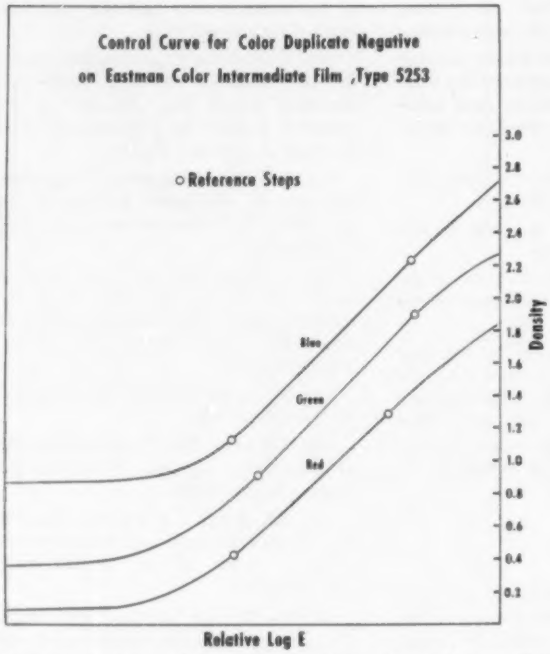

Fig. 8. Control curve for color duplicate negative with densities of reference steps, as printed from color master positive.

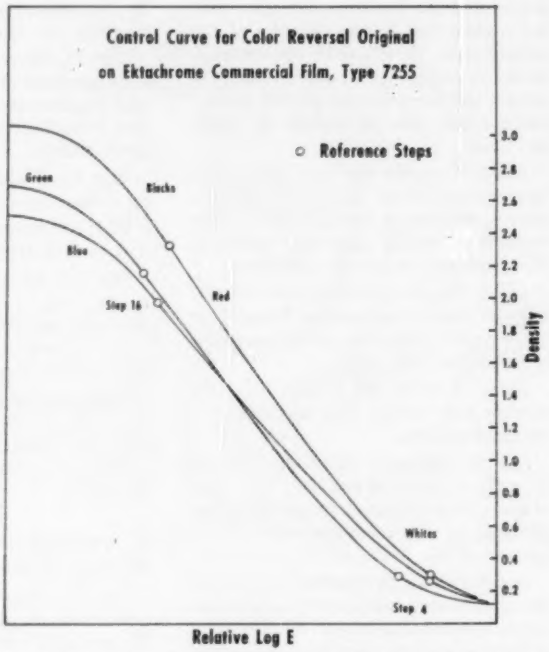

Fig. 9. Control curve for color reversal original with reference steps.

judge whether the internegative has been made correctly are the manner in which the picture information is situated on the internegative control curves and the quality of the final print. The following step-by-step procedure is used:

Step 1. Expose a sensitometric control strip on Ektachrome Commercial Film, Type 7255. This should be a neutral exposure scale.

Step 2. Have the control strip processed in the normal ECO-1 process (or subsequent process used).

Step 3. Measure the integral densities of the Ektachrome Commercial control strip to blue, green and red light.

Step 4. Plot the curves for the control strip (see Fig. 9).

Step 5. Measure the highest and lowest integral densities to blue. green and red light for typical scenes of the picture footage to be duplicated.

Step 6. Indicate on the control curve the step numbers whose densities most closely match the picture densities. These are the reference steps for the duplication process (refer to Fig. 9).

Step 7. Examine the process to be used for Eastman Color Internegative Film, Type 7270 in order to make sure that it conforms to standard.

Step 8. Print the Ektachrome Commercial control strip onto Color Internegative Film, Type 7270. Use the same emulsion that is to be used for printing the picture footage. See Appendix for printing conditions.

Step 9. Expose a sensitometric control strip on the same Type 7270 stock.

Step 10. Process the printed strip and control strip together in a normal process for the Type 7270 Film.

Step 11. Measure the integral densities to blue, green and red light of the control strip and the reference steps of the printed strip.

Step 12. Plot the characteristic curves for the control strip, and plot the positions for the densities of the reference steps of the print-through (Fig. 10).

Step 13. The reference steps should plot on the linear portion of the control curves. If they do not, an adjustment in the exposure must be made.

Step 14. When the exposure level has

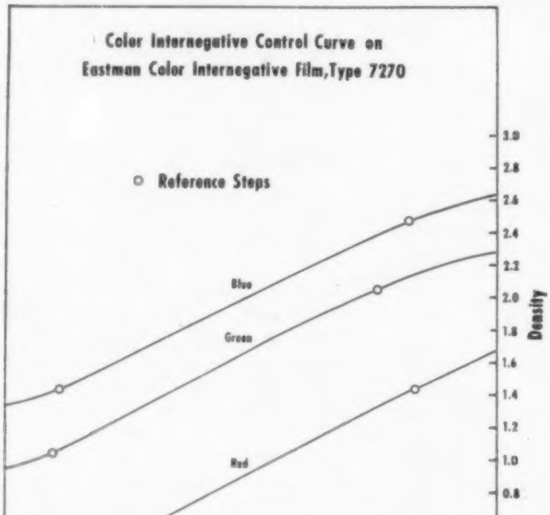

Fig. 10. Control curve for color internegative with densities of reference steps, as printed from original.

been adjusted, the picture footage together with the Ektachrome Commercial control strip should then be printed onto the Type 7270.

Step 15. Expose a sensitometric control strip on Type 7270 for inclusion with the picture footage.

Step 16. Process the color internegative and control strip, measure the densities as before, and locate the position of the densities of the reference steps on the control curves. This serves as a check on the printing and processing operations.

Step 17. The final check is to print the color internegative onto the color release print stock (Eastman Color Print Film, Type 7383) and evaluate the quality by projection.

Often some confusion arises in examining the curve as to just where the straight-line portion begins. For the currently available Type 7270 Film, the straight-line begins for all three curves at an approximate density of 0.30 above minimum density. It should be noted, however, that the minimum density and curve shape may be different for each laboratory process. Also, it is conceivable that this situation may change with further product improvements.

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APPENDIX

I. Sensitometric Exposures

Film type	Lamp wattage	Lamp color temp., K	Exposure time, sec	Filters
5250 Color Negative	40 (10-amp 39.5 cp)	2650	1/50	Corning 5900 (1.51mm) (converts to approximately 3150 K)
5253 Color Intermediate	900	2850	1/25	Corning 3307 plus Wratten No. 2B plus Pittsburgh heat-absorbing glass No. 2043 (4mm)
5235 Red Separation	900	2850	1/10	Wratten No. 70 plus Pittsburgh heat-absorbing glass No. 2043 (4mm)
5235 Green Separation	900	2850	1/10	Wratten No. 99 (or Wratten No. 16 plus Wratten No. 61) plus Pittsburgh heat-absorbing glass No. 2043 (4mm)
5235 Blue Separation	900	2850	1/10	Wratten No. 98 (or Wratten No. 47B plus Wratten No. 2B) plus Pittsburgh heat-absorbing glass No. 2043 (4mm)
7255 Ektachrome Commercial	40 (10-amp 39.5 cp)	2650	1/50	Corning 5900 (1.51mm) (converts to approximately 3150 K)
7270 Color Internegative	900	2850	1/10	Wratten No. 2B plus Pittsburgh No. 2043 heat-absorbing glass

II. Densitometers

A. Integral densities of Types 5250, 5253, and 7270 Film were obtained on an Eastman Electronic Densitometer, Type 31A, using Status K red, green and blue filters.

B. Integral densities of Types 5235, 5382, and 7383 Film were obtained on an Eastman Electronic Densitometer, Type 31A, using Status A red, green and blue filters.

III. Printers and Printing Conditions

A. Type 5250 Printed Onto Type 5253 (Color Master Positive)

Printer: Bell & Howell, Model D (continuous, subtractive). A step contact printer would be preferable.
Speed: 60 fpm *Lamp:* 300-w, 3000 K *Diaphragm:* #17
Filters: Kodak Color Compensating Filters 50Y, 15M, 40C, Wratten Filter No. 2E, Pittsburgh 2043 (4mm)

B. Type 5253 Printed Onto Type 5253 (Dupe Negative)

Printer: Acme, Optical (intermittent film movement)
Lamp: 750-w *Speed:* 15 fpm *Shutter:* 170° *Aperture:* f/4.0
Filters: Aklo, Wratten Filter No. 2E, Kodak Color Compensating Filters 20Y, 05M, 25C

C. Type 5250 Printed Onto Type 5235 (Black-and-White Master Positives)

Printer: Acme, Optical, step printer
Lamp: 750-w
Shutter: 170°
Red Exposure: speed, 20 fpm; aperture, f/4.0; filters — Aklo, 0.70 neutral density, Corning 2403
Green Exposure: speed, 20 fpm; aperture, f/4.0; filters — Aklo + Corning Filter Nos. 3484 and 5032
Blue Exposure: speed, 10 fpm; aperture, f/2.8; filters — Aklo + 0.10 neutral density + Corning 5543

D. Type 5235 Printed Onto Type 5253 (Dupe Negative)

Printer: Acme, Optical, Step printer
Lamp: 750-w
Shutter: 170°
Red Exposure: speed, 20 fpm; aperture, f/4.0; filters — Aklo + Corning 2412
Green Exposure: speed, 20 fpm; aperture, f/2.8; filters — Aklo + Corning Filter Nos. 3484 and 5032
Blue Exposure: speed, 20 fpm; aperture, f/4.0; filters — Aklo + 0.60 neutral density + Corning 5543

E. Type 7255 Printed Onto Type 7270 (16mm Internegative)

Printer: Bell & Howell Model J (continuous, contact, subtractive)
Lamp: 300-w, 3000 K *Speed:* 30 fpm *Diaphragm:* #18
Filters: Wratten Filter No. 2B, Pittsburgh 2043 (4mm), Kodak Color Compensating Filters 30Y, 20M, 30C

A New 8mm Magnetic Sound Projector

By R. J. ROMAN,
J. M. MORIARTY
and R. B. JOHNSON

The new Sound 8 Motion Picture Projector is described. Illustrations present a detailed product analysis covering basic construction, the projector drive, sound drive and electronic system. Major aspects of projector performance are presented together with some comments on this use and future of this development.

Sound projectors are creating a new dimension for 8mm movies. Sound can be recorded on, and reproduced from, a tiny 30-mil magnetic oxide stripe placed between the sprocket holes and the edge of 8mm film.

The premise in this paper is that 8mm sound can be excellent and that the Kodak Sound 8 Projector can produce such results consistently.

The projector has a 400-ft film capacity, folding reel arms, claw framing, swing-out gate, and a projection optical system capable of screen illumination averaging over 100 lumens with a $\frac{3}{4}$-in. *f*/1.6 projection lens.

A large propeller-shaped knob at the front (Fig. 1) facilitates elevation. This rack and pinion system resists back turning of the pinion, thus achieving stability without a separate lock.

The unit has a $2\frac{1}{2}$-w record-playback amplifier built into the base, and a $2\frac{1}{2}$ by 10-in. loudspeaker is mounted in the front of the case. Its 500-w internal reflector-type projection lamp is cooled by a high-capacity centrifugal blower system designed to handle twice the wattage. As a result, the projector and aperture temperatures are low, and projection lamp life is increased.

The projection control panel has separate motor and lamp power switches in addition to a lamp brightness selector. In its "normal" position, reduced voltage increases lamp life by a factor of ten while reducing light output only 40%. This is particularly important since much of the sound recording and editing will be done with the projection lamp on.

The projector has two forward operating speeds, reverse, and still projection, with internal braking at the still position. All of these functions are controlled from the single projector control knob shown in Fig. 1.

A shutter shaft access panel behind the thread knob allows external devices to be plugged into the shutter shaft without removing the thread knob. This opens a wide range of possibilities such as tying two projectors together, mounting a synchronous drive, or even driving a camera directly from the projector for frame-to-frame synchronization.

Amplifier Control Panel

Simplified function is the keynote of the amplifier control panel. A single volume control serves for both record and playback. The record-playback switch is interlocked to prevent accidental actuation, yet can be operated with one hand. A red record light is also prominent on the panel.

The unit will accept simultaneous microphone and phonograph inputs. Both levels are controlled by a simple peak level indicator. A remote loudspeaker jack is also provided. The unit can be coupled directly to one or more external speakers by means of this jack, or when loaded with an 8-ohm 5-w resistor, can be used to drive an external power amplifier.

This single jack provides the option of disconnecting the built-in speaker, or letting it operate in parallel with the external connection for interesting depth effects.

The amplifier control panel is part of the steel plate screwed to wood blocks in the base of the case which mounts the amplifier. The mechanism frame is seated on this plate and secured by screws. The opposite side of the frame is screwed to the channel that mounts the carrying handle. Thus the upper case gives lateral support but is isolated from carrying strains.

Sound Drive Performance

Figure 2 shows the unique sound drive unit. It is a drum-scan type with pressure roller, movable magnetic heads, and a film stabilizer. All can be opened and held open for threading by a single lever.

The sound system operates with frequency flutter less than 0.16% rms and wow less than 0.4%. The 24-frames/sec frequency response (−15 db) is 70 to 9000 cycles and is ±3 db from 85 to 7000 cycles. The 16-frames/sec frequency response (−15 db) is 70 to 7000 cycles and is ±3 db from 85 to 5000 cycles. Using Kodak 8mm Sonotrack, total amplitude modulation at 1000 cycles averages less than $\pm\frac{1}{4}$ db.

The single most important feature for the unskilled sound recorder, besides good sound, is "instantaneous sound stabilization." The drive actually comes up to speed and is ready for recording or playback in less than one second. Note the

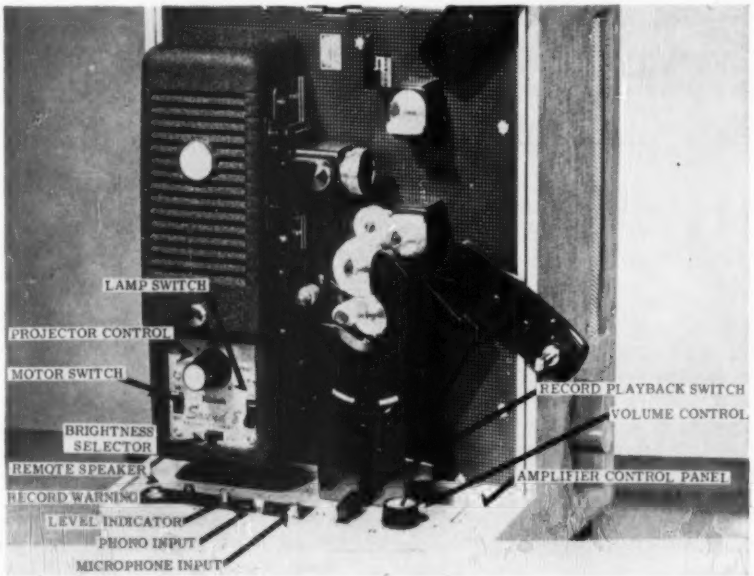

Fig. 1. Exterior view of the Kodak Sound 8 Projector.

Presented on May 4, 1960, at the Society's Convention in Los Angeles by R. J. Roman (who read the paper) J. M. Moriarty and R. B. Johnson, Apparatus & Optical Div., Eastman Kodak Co., Rochester 4, N.Y.
(This paper was first received on August 23, 1960, and in final form on November 30, 1960.)

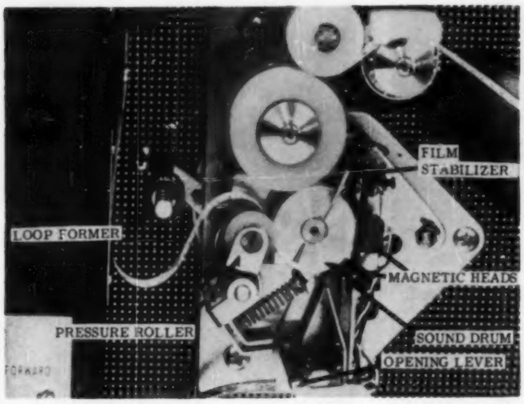

Fig. 2. Sound drive unit, front view.

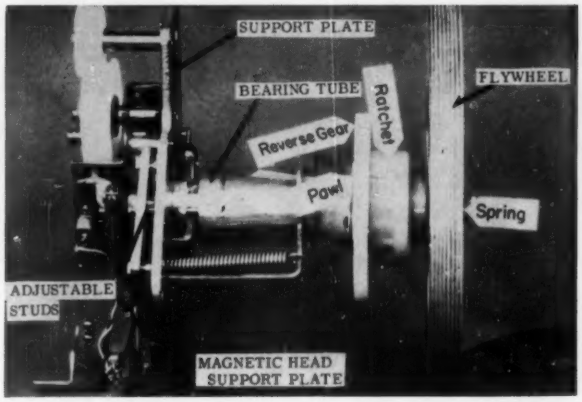

Fig. 3. Sound drive unit, side view.

loop former (Fig. 2) for precise setting of sound-picture separation.

Structure of Unit

In order to maintain the delicate alignment required for 8mm sound, design emphasis was placed on structural strength and ability to absorb shock. The sound drive unit shown in Fig. 3 is designed to be strong and extremely rigid.

The sound shaft and drum assembly is supported by sleeve bearings set into both ends of an aluminum bearing tube. The tube is screw-clamped at right angles to a $\frac{1}{8}$-in. thick support plate forming a basic "T" structure. These parts are so stable and accurate that they are completely interchangeable, even in the field.

The magnetic heads are mounted to a smaller support plate held against the large plate by a spring which is anchored at the other end to a bracket that is also supported by the large plate and the bearing tube.

This magnetic head support plate stands on three adjustable studs, which in turn capture steel balls that make actual contact with the large plate. The two upper balls ride the flat surface of the large plate. The lower ball is larger and seats in a conical socket of the large plate, forming a fixed pivot.

A flywheel, weighing approximately two pounds, mounts on the sound shaft and is driven through a slip clutch formed by a ratchet fixed to the shaft in front of the flywheel, and a spring assembly fixed to the end of the shaft.

The reverse flywheel drive gear rotates about the outside diameter of the bearing tube and is driven continuously by the mechanism. A directional clutch pawl carried by this gear engages the ratchet for positive drive when the mechanism is in reverse, and runs completely free of the ratchet during forward operation.

The flywheel consists of eight identical steel laminations mandrel-stacked with succeeding laminations displaced 90°. This evenly distributes the imbalance of individual laminations so that when welded together the unit is in static balance.

The projector's basic frame is shown in Fig. 4. Interlocked steel plates form an "egg-crate" structure reinforced with five tie bolts. The sound drive unit is mounted to the front frame plate, using three widely spaced standoffs. The bearing tube is supported by the rear frame plate, but is free to move axially relative to it.

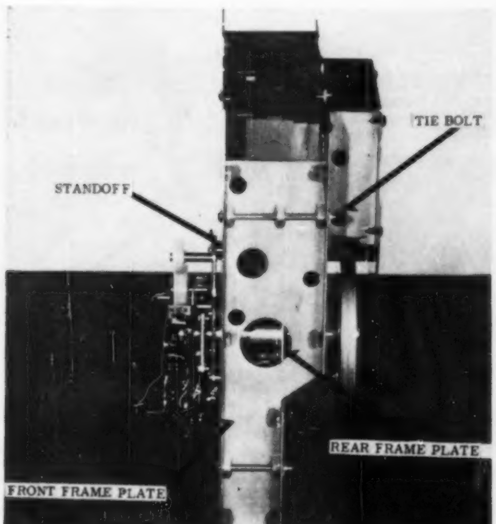

Fig. 4. Projector's basic frame.

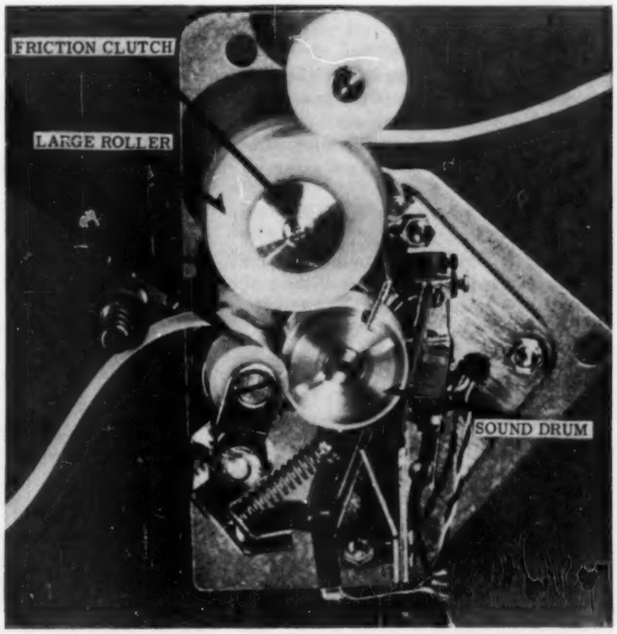

Fig. 5. Front view of unmounted sound drive unit.

This construction allows the rigid sound drive to move as a unit relative to the frame. Since all critical sound adjustments are made on the rigid sound drive, malfunctions of the sound system, resulting from rough handling, have been virtually eliminated.

Function of Sound Drive System

A front view of the sound drive (Fig. 5) will serve for identification of elements and description of function.

Film is pulled through the unit by a 16-tooth sprocket placed as close to the upper idler roller as practical. Film enters the unit from a free loop fed by the projector pulldown. It then passes between the small pressure roller and the sound drum. The roller serves to isolate fluctuations in the free loop, establish film wrap on the drum, and control tracking of the film on the drum.

The large roller serves as primary support for film between the sprocket and sound drum. Equipped with a friction clutch, it also adds a small fixed amount of film drag to that supplied by the magnetic heads and bearing friction in the system.

This combination constitutes a low pass filter which effectively attenuates unavoidable flutter produced by engagement of sprocket teeth with film perforations, and by irregularities in the driving gear train. Periodic low-frequency disturbances are only slightly reduced, and if present in the sprocket drive system, can result in audible wow. However, these disturbances are avoidable, and in practice are held to an inaudible level.

The tight film coupling between sprocket and drum accounts for most of the system's rapid sound stabilization performance.

Record-Playback Head

The magnetic record-playback head is shown in Fig. 6. Much of the 8mm projector's sound performance depends upon its design and manufacture, how well it tracks the stripe and maintains its setting.

Alfenol pole pieces 20 mils thick are set into nylon bobbins around which coils are wound. The counterwound pair are cemented together with a $\frac{1}{4}$-mil shim of beryllium copper forming the front gap. At this stage the head (resembling that shown at the right in Fig. 6) can be checked for its inductance of approximately 14 millihenries.

The head is mounted in a mu-metal shield case (at the left in Fig. 6). Eyelets, placed over bobbin projections previously used as mounts for coil winding, form rugged terminals. This assembly, plus a terminal insulator, is potted into the shield can with an epoxy material.

The head, being 20 mils wide, can track the middle of a 30-mil stripe, thus decreasing edge effects. Alfenol pole pieces are the key to successful narrow head tracking. This material, developed by the U.S. Navy, has the magnetic properties of mu-metal but is physically much harder. Developments in the use of this material have produced a head capable of maintaining precise gap definition throughout a life several times that of the projector itself.

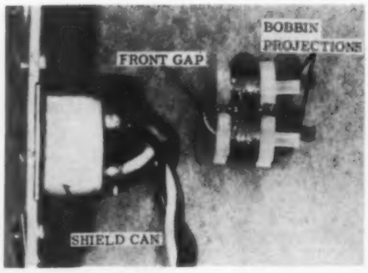

Fig. 6. Magnetic record-playback head.

Fig. 7. Pressure roller system.

In addition to head width, placement, and gap definition, such factors as pole piece shape and scanning on a 1-in. drum form the basis of a sound system with low-distortion and high-frequency response.

Pressure Roller System

The prime function of the pressure roller system (Fig. 7), is to assure correct position of film on the sound drum. This system is similar to other systems in that film rides against the pressure roller's outboard flange under force from upward cant of its axis relative to that of the sound drum. The roller must apply uniform pressure and maintain its cant and lateral position without introducing aberrations. This means it must have excellent bearings, little runout, and accommodation for film irregularities.

The roller applies uniform force to both edges of the film by action of a spring through the center ball pivot. It is also supported in space by action between the spring, pivot, lower support ball, and sound drum.

This unique suspension presents negligible resistance to incremental pivoting about an axis through the center of the support balls. Since restoring forces are inherently small, the roller must be particularly free to pivot on this axis in order to accommodate irregularities in narrow 8mm film.

Accuracy of Unit

Our answer to the paradox of 8mm sound can be summarized as follows: Greater accuracy in the sound drive is achieved by using rugged but inexpensive stamped parts spring-loaded to operate with zero clearance.

The drive unit at the left of Fig. 8 is shown in its closed or sound operating position. When the actuating lever is pushed to the open or thread position, several things happen simultaneously. The level rotates about the sound shaft bearing tube, and a projection on it cams opens the pressure roller. Simul-

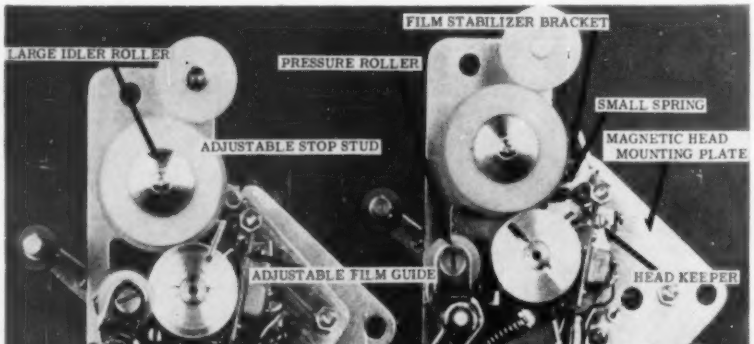

Fig. 8. Drive unit in its closed or operating position at left, and at right in its open position.

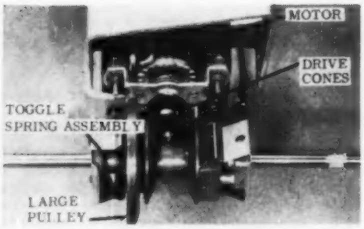

Fig. 9. The drive in the 24-frames/sec forward position.

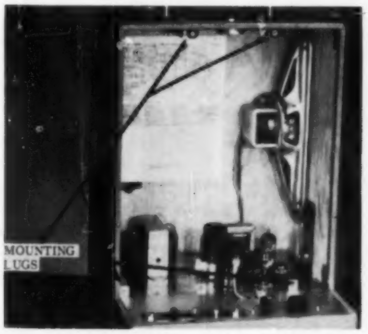

Fig. 10. Amplifier and loudspeaker mounted in the case.

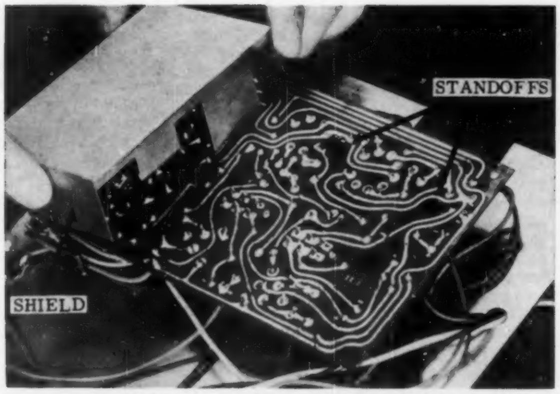

Fig. 11. Circuit board showing standoffs which suspend the amplifier.

taneously a second projection on the lever causes the magnetic head mounting plate to pivot about its lower stud. The spring-loaded ball suspension of this plate was previously described.

The film stabilizer bracket is free to pivot about the large idler roller shaft, and is linked to the magnetic head plate by a small spring. As the magnetic head plate pivots, the spring connection forces the stabilizer to rotate about its pivot also.

When the unit is closed, a third projection on the lever pushes on the stabilizer bracket causing it to pivot clockwise. The spring link now causes the magnetic head plate to pivot until it contacts an adjustable stop stud. Further clockwise rotation of the bracket extends the spring to supply positive closing force required by the magnetic head system.

Adjustable film guides prevent overthreading or film movement beyond the inner limits of the drum, and the stabilizer guards the outer limits. In addition, all rollers are undercut to clear the picture area, and an adjustable head keeper prevents the magnetic head from touching the unloaded drum.

Induction Motor

The projector is driven by a shaded pole induction motor operating at approximately 3200 rpm. Smooth coupling of the motor and shutter shaft is achieved with this multispeed transmission.

The drive (Fig. 9) is shown in the 24-frames/sec forward position. Downshift to 16 frames/sec is accomplished by movement of the large pulley until contact is made with the large drive cone. Over-the-center toggle-spring action involved in this motion causes the small pulleys to separate slightly, thus completing transfer to the lower speed drive.

Still projection is accomplished by moving all pulleys out of engagement; and 24-frames/sec reverse, by contact with the opposite small pulley.

Shift rollers actuated by the projector control knob regulate pulley movements and are in contact only when shifting.

Amplifier System

In Fig. 10 the amplifier and loudspeaker are shown mounted. A combination circuit diagram, parts list and tube replacement chart is stapled to the case. Lugs for mechanism mounting are on the amplifier support plate and handle support channel. When the projector mechanism is inserted into the case, it will seat several amplifier components.

The amplifier has a line-isolated power supply and a transformer output capable of feeding an 8-ohm load with 2½-w at less than 3% total harmonic distortion.

A 2N228 transistor preamplifier is used to couple the magnetic head to a vacuum tube section consisting of two ECC83 voltage amplification stages and a single-ended EL84 output stage.

Bias and erase signals at 40 kc are supplied by a single-ended 6C4 vacuum tube oscillator. One feature of this circuit is that the high impedence phonograph input in playback can be used as an equalized output for direct connection to the preamplifier or amplifier of an external installation.

Amplifier Circuitry

The amplifier is a printed circuit type. It is suspended underneath the support plate by standoffs (Fig. 11) and is stable yet flexible. When standoffs are correctly placed, this construction will withstand flexure of the support plate by as much as 15° without damage to connections, circuit board, or mounted components.

Figure 11 also illustrates the technique used to shield critical stages without removing them from the circuit board. Although this does not constitute 100% physical shielding, it is more than adequate. Excepting the shield, all parts of the unit are completely assembled before dip soldering, thus minimizing internal strains and damage to connections from handling.

The most significant feature of the record-playback amplifier is its use of distributed switching. Mechanical interconnection of switches placed at their natural circuit positions results in a unit having exceptional stability.

Future Outlook

It is hoped that this projector will contribute to the growth of a new industry that is the potential of 8mm sound movies. Amateurs will be able to create sound-on-film records, prepare entertainment films that compare with professional efforts, and purchase or borrow from an increasing selection of professionally made prints. Another expected growth area of 8mm sound motion pictures is in the field of business reports and industrial films.

Discussion

Frank W. Mango (I.A.T.S.E.): Your reproduction seems to be completely free of wow and flutter as far as I can tell, and that seems to be even better than the reproduction I've heard from some professional 16mm reproduction, including perhaps the Model 25.

Mr. Roman: The figures which I quoted and the performance of this machine are indeed equal to some professional equipment. The amplitude flutter which has been characteristic of narrow-stripe materials is just about completely inaudible here. The frequency response, because of techniques developed in the manufacturing of the heads and the way that it is scanning, is considerably better than many 16mm optical projectors. I don't think this is because the optical projectors can't be better, but because release prints, on the average, haven't been better and the projectors tended to follow suit.

Mr. Mango: Is there any physical resemblance between the sound reproducting portion of this unit — that is so far as your design in general is concerned — that bears any similarity to Model 25, or is it a completely different design?

Mr. Roman: The actual construction of the

unit does not bear any similarity to any unit that has ever been made to the best of our knowledge. However, it is basically a drum-scan type, which is classic of course in the motion-picture art. In order to get the instantaneous starting response, the drive system is close-coupled to the sprocket much like a tape recorder.

Loren Ryder (Ryder Sound Services, Inc.): May I ask how this recording was made? Also, would you elaborate a little on how you intend to put the sound on the film; I understand you have a microphone to go along with the projector, and you have a jack to put it in, but to tie it in with camera shooting, or that type of work, is there any plan for that?

Mr. Roman: Well, of course there is a good deal of thought about that. This particular recording was made on this machine, and it is being played back from it. The original was a standard 33-rpm disc.

This is a re-record type of projector for the amateur. Because it starts so quickly, sounds as good as it does, because it brakes, and reverses through the sound system, it gives the customer the ability to do re-record sound on film, to do lip sync by re-record techniques. Cameras can be modified to be driven synchronously from the projector, or you can hook any of the standard synchronous motor line synchronizing devices to it for the shooting of double-system sound.

Mr. Ryder: Is there a shaft standing there? And is it driving at 1440 or 1800 rpm?

Mr. Roman: At 24 frames/sec the shaft rotates at 1440 rpm. There's a slot in the shaft and when you remove a plate you can plug a flexible shaft directly in without doing anything else. In addition to that, there are T-studs in the back so that you can screw a piece of equipment directly to the case.

Don G. Williams (University of Kansas City): Has there been any thought of making this without any record and erase head, for use in school? That is, playback only?

Mr. Roman: Not at this particular moment. From a technical point of view, there is no reason why such a thing could not be done. A projector of this type could be bought by a university and the record part of it could be disabled very easily. Or, we could put out machines which did not have the record feature at all. Unfortunately, the savings sometimes do not amount to as much as you might think.

Donald C. McCroskey (American Broadcasting Co.): Has there been a sound-picture separation standard established by the SMPTE?

Mr. Roman: Whatever spacing is determined by SMPTE we will set on the projector. The spacing knob can be placed in any position from about 39 to about 60 frames without trouble.

Ultra-High-Speed Streak Camera Utilizing Mirror Optics

By JACK M. PATTERSON

Parameters for conventional sweeping-image camera design are easily exceeded through the use of a new mirror optical-relay system. This optical configuration allows all components to be arranged in a simple on-axis design. The incorporation of mirror optics into streak camera design opens new areas of observation and new fields of application.

The conventional sweeping image camera with its transmission optics has been used with very little change in design for almost seventy years. No other type of instrumentation can provide such extremely accurate velocity measurements of self-luminous transient events. Increasing interest in high-speed phenomena has placed new requirements upon existing streak cameras. Beckman & Whitley camera engineers proposed a sweeping image camera design to optimize optical and newly developed mechanical elements. This design makes it possible to obtain a time resolution six to ten times that of present configurations. The principal advances of the Model 339B Streak Camera have been made by incorporating mirror optics into the camera's relay system and making use of the latest technology in rotating mirror turbine design. These improvements utilize a simple on-axis design (Fig. 1), and eliminate troublesome components from the optical system which were previously necessary. Such improvements help meet the increasingly severe demand on photographic instrumentation for accurate data of ultra-high-speed phenomena.

Presented on May 3, 1960, at the Society's Convention in Los Angeles, by Jack M. Patterson, Beckman & Whitley, Inc., 973 San Carlos Ave., San Carlos, Calif.
(This paper was received on August 29, 1960.)

The Optical System

The optical system of the 339 Camera is arranged to function in the following manner: A normal transmission objective is used to form the image of the subject under study on the slit. A relay mirror optical system of 24-in. focal length allows the film track to be positioned directly across the optical axis. As illustrated, the relay system consists of a small aspheric lens to collect the light from the slit and the large spherical mirror which brings the optical path onto the rotating mirror and subsequently to the film plane where the slit image is formed.

Careful design of the mirror optics and

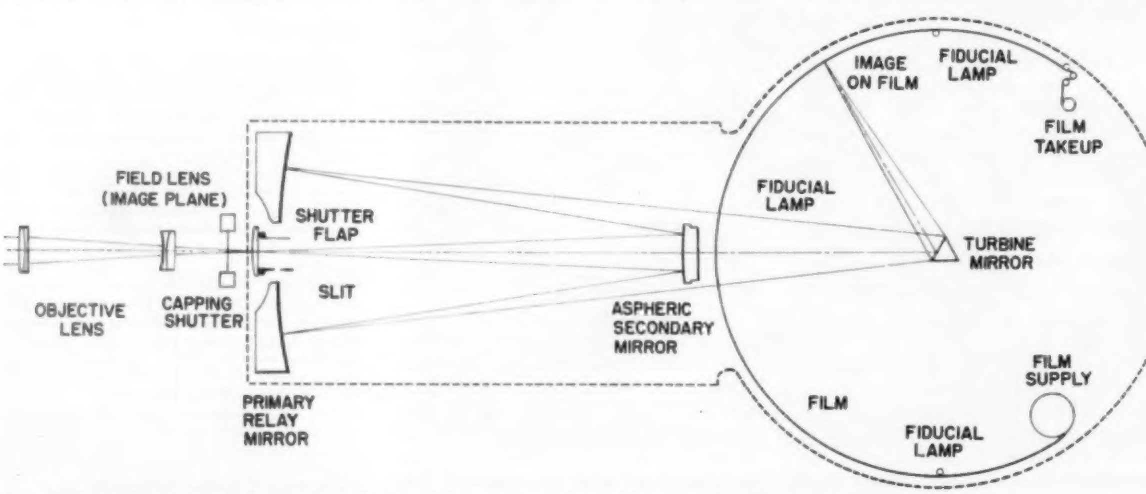

Fig. 1. Optical schematic of on-axis design used in Beckman & Whitley Model 339B Streak Camera.

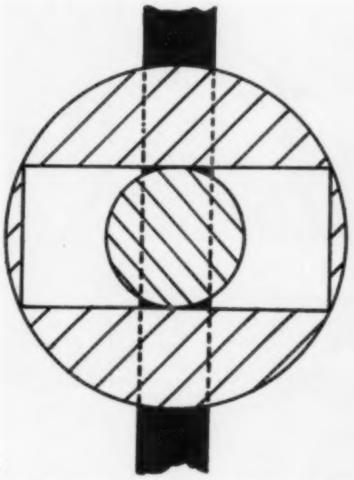

Fig. 2. Illustration showing no loss of light by film track across optical axis and size relationship of relay mirrors to the rectangular mirror surface.

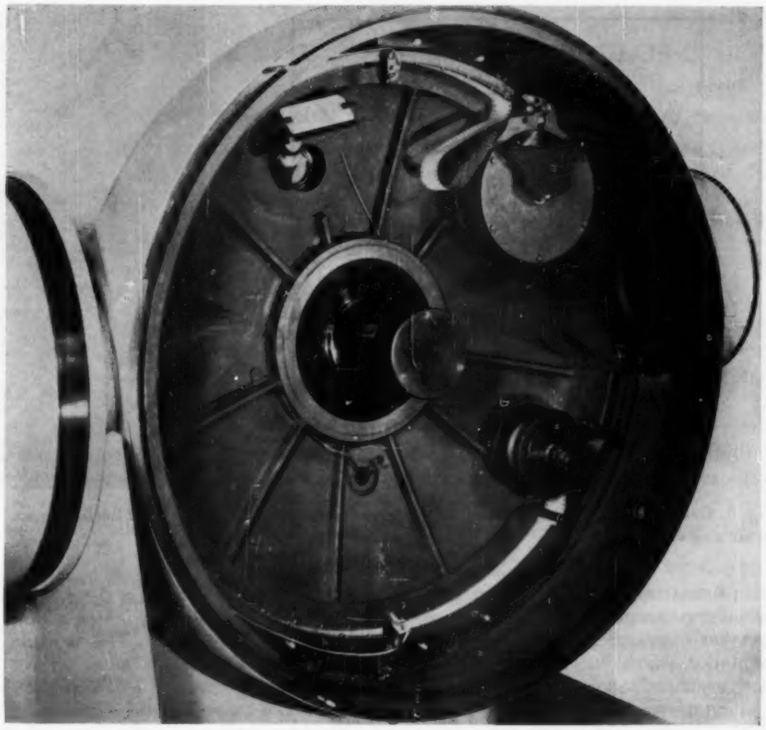

Fig. 3. Interior view of Model 339 Streak Camera.

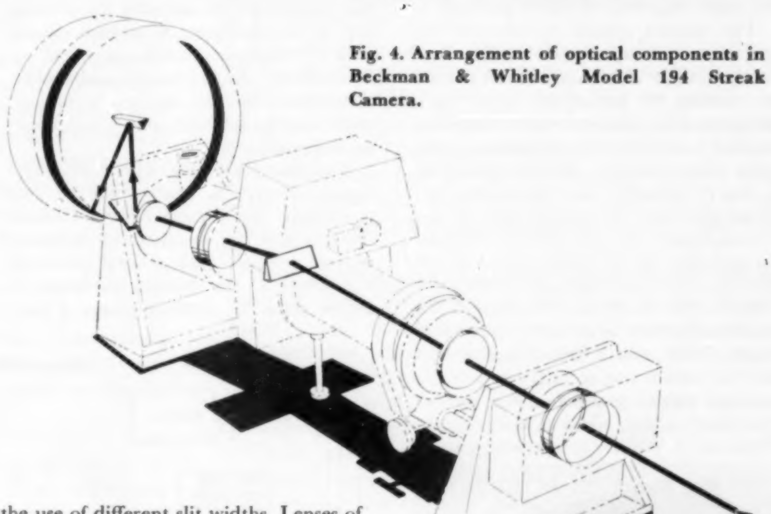

Fig. 4. Arrangement of optical components in Beckman & Whitley Model 194 Streak Camera.

rotating mirror allows this on-axis placement of the film track with zero loss of light. Figure 2 illustrates the proportionate size relationship of the aspheric relay mirror and film track to one of the rectangular faces of the rotating mirror as seen through the aperture of the large spherical relay mirror. A view of the camera interior (Fig. 3) shows more clearly the position of the mirror turbine, film supply, track and film take-up.

This streak camera replaces the Beckman & Whitley Model 194 which used a transmission relay system and a 45° angle folding mirror to bring the optical path onto the rotating mirror. The off-axis difference of only 5° at the rotating mirror required an optical wedge in the system in order to bring the image plane coincident with the film track. The necessity of this optical component and the folding mirror is eliminated in the Model 339. A thorough evaluation of the new design proved the following specifications to be realistic:

Writing period: continuous
Writing rate, maximum: 9 mm/μsec
Mirror speed, maximum: 2600 rps
Effective aperture ratio: $f/8$
Time resolution with 0.0015 slit: 5×10^{-9} sec
Total writing time, minimum: 131 μsec
Film: standard 35mm
Film length: 48 in.

A slit is used in the optical system so that only light from a selected portion of an event to be photographed is permitted to enter the camera. This slit is located behind a field lens which forms a vacuum port and more effectively fills the small aspheric lens with light. The field lens can easily be removed to permit the use of different slit widths. Lenses of different focal length can be adapted for more versatility in operation.

Continued experimentation sought to produce a mirror turbine assembly having the following characteristics:

(1) no corrector lens required at high writing rate;

(2) minimum distortion for higher real and "theoretical" time resolution;

(3) internal vacuum oil seals; and

(4) high surface reflectivity.

Eventually, a rotating mirror turbine assembly utilizing beryllium in the mirror construction made the high inherent time resolution of 5×10^{-9} sec a realistic advantage. The unique property of beryllium in its relationship of elasticity to mass eliminates the problem of mirror deformation common to those of steel construction. Throughout its operating range to 2600 rps it is virtually distortion free. This maximum rotational speed and a writing arm length of 11 in. produce a writing rate of 9 mm/μsec.

Applications

The Model 339 Streak Camera is finding wide use in the study of events such as explosions, shock-tube studies, flash tube and spark discharge phenom-

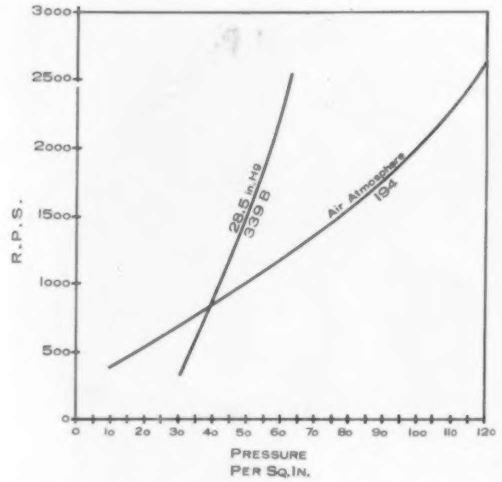

Fig. 5. Graph for comparison showing turbine operation in air and vacuum.

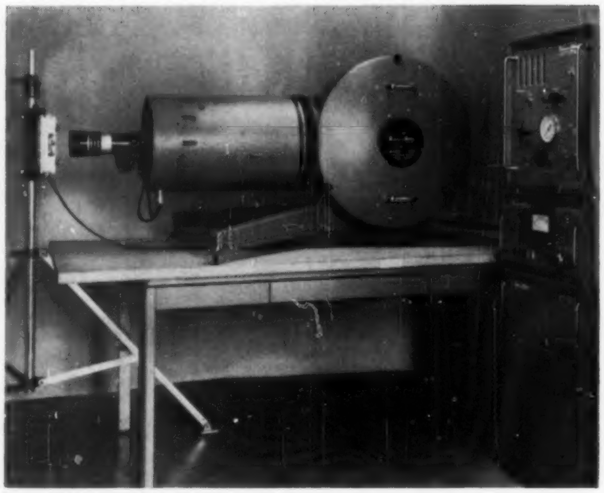

Fig. 6. The Beckman & Whitley Model 339 Camera with control system.

ena. Recent emphasis placed on space propulsion systems and plasma investigation has increased the need for instrumentation which does not require subject synchronization. The triangular rotating mirror facilitates the continuous writing feature and assures a record of the event regardless of mirror position.

The camera chassis construction incorporates a vacuum sealed housing. Image quality is substantially improved by rotating the high-speed mirror in a vacuum. This eliminates any resolution loss due to air turbulence in the proximity of the mirror surface. Turbine operation is greatly simplified as maximum rotational speed can be attained with the use of compressed air as a driving medium. In operation at all pressures over 40 psi there is a continual increase in efficiency (Fig. 5) over the Model 194 although the beryllium mirror is actually three times larger. Until now a lighter-than-air gas such as helium was necessary in order to operate mirror turbines of this type at maximum speed. Optical engineers at Beckman & Whitley are presently working on special applications of this camera to record event emissivity which is outside the visible spectrum. This is made possible through the use of all mirror optics and a quartz field lens which admit ultraviolet wavelengths.

The Model 439 is a modified version of this camera which increases the writing rate to 24 mm/μsec. A smaller mirror with a maximum rotational speed of 7000 rps and the film track positioned to compensate for the change in optical path length produce this exceptional writing rate.

The Model 339 (Fig. 6) is completely equipped with a control for remote operation. This remote control enables the operator to continuously monitor mirror rotation and control pressure regulation of the driving medium. A trigger pulse for event initiation is also provided by the remote control unit. The entire control system is illustrated in the block diagram (Fig. 7). A Model 329 High Voltage Pulse Unit supplying a 5000-v pulse at 25-wsec and a Blast Shutter are included in the operating assembly. The Blast Shutter (Fig. 8) is a fast closing device to eliminate rewrite should the event illumination persist for a longer period than the writing cycle of the camera. It requires only 12 μsec from full open to full closed.

Constant research continues to bring forth new problems for ultra-high-speed photography. The need for instruments such as the Model 339 to provide high writing rates without proportionate image degeneration will grow as the search continues for greater time resolution to increase the accuracy of data assessment.

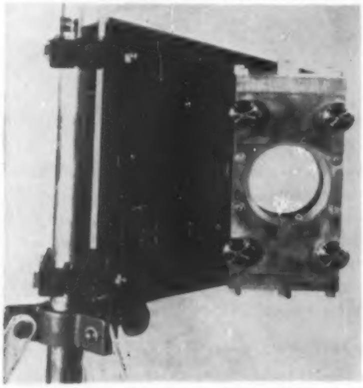

Fig. 7. Blast shutter, a fast closing device used with high-speed cameras will cut off subject illumination in 12 μsec.

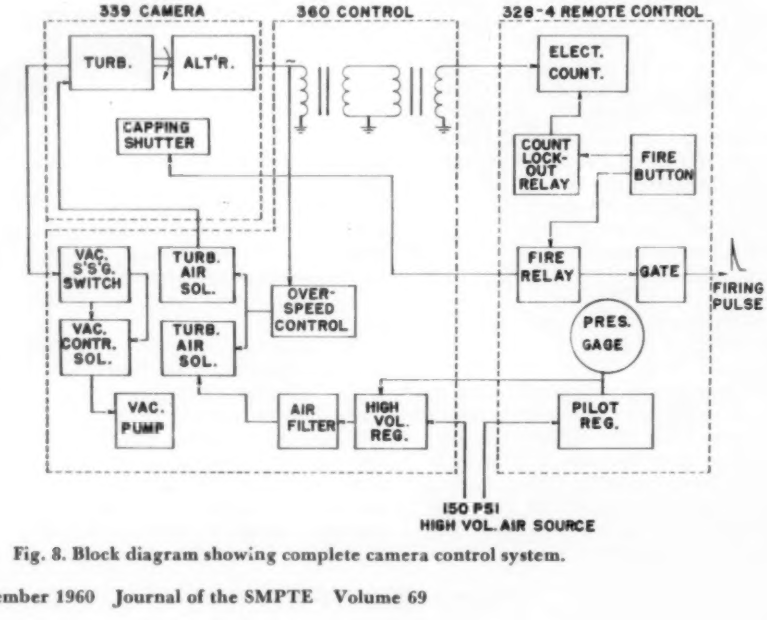

Fig. 8. Block diagram showing complete camera control system.

Kerr Cell Framing Camera

By WILLIS C. GOSS

Design of a high-speed Kerr cell framing camera is described. A single Kerr cell, pulsed once, is used in conjunction with a system of optical delays to provide six consecutive pictures at interframe times of 1.5×10^{-8} sec and exposure times of 5×10^{-9} sec. The camera is f/10 at the 35mm film plane and the pictures have roughly 240×600 information lines content. Source image threshold energy is expected to be at an effective blackbody temperature of $\sim$0.5 ev for Tri-X film. It is expected that the camera will find extensive use in exploding-wire studies as well as high-energy-explosive hydrodynamics.

During the past several years a strong need has developed for high-resolution sequence-framing cameras which are faster than the available models. Hydrodynamics is being studied at higher temperatures and with smaller samples, so that "on film" particle and shock velocities are higher. Electrically exploded wires have become a lively research subject in their own right. Both these fields of inquiry and many others could benefit from the availability of cameras with framing rates of the order of 10^8/sec or greater.

Rotating mirror cameras with high resolution simply cannot be extended to this range. The Schardin limit to rotating mirror resolution quickly shows us we could expect about ten line pairs total in the framing direction for a 1×10^8 frame/sec camera. Image dissection and grid framing techniques can improve this number to a very useful value,[1,2] but both suffer from data reduction and rewrite problems.

Existing Kerr cells and electronic image converter tubes have shuttering times within the range of interest,[3, 4] but to date both are "single shot" devices incapable either of switching image location between successive exposures without auxiliary optical systems, or indeed, of making successive exposures at all at rates sufficiently fast to be of interest here. The usual choice made is between lining up a number of identical shutters with triggering delays between units to view a single event,[5] or shooting a series of presumably identical events with a single recording unit set with successively longer triggering delays for each shot. The first method is costly in initial outlay and in electronic maintenance. The second method is frequently costly because the event is expensive; in any case, experimental results are somewhat open to question.

A third method, and one which we feel is to be preferred, is to present the Kerr cell or image converter with a number of images of the same event, with each image time optically delayed a time increment $n\Delta t$ with reference to the event time scale, where the images are numbered $n = 0, 1, 2, \ldots$. The Kerr cell or image converter then shutters all of these images simultaneously to record them on a single camera film plane. Such a technique was mentioned by E. W. Walker of the United Kingdom at the Fourth International Congress on High-Speed Photography.

This optical delay method appeared to us to have more potential than any other currently feasible scheme. A number of criteria were considered before proceeding:

(1) The shutter should have an exposure time less than 10^{-8} sec, and jitter less than the shuttering time.

(2) The total number of frames should be as large as possible.

(3) Each frame should exhibit good resolution, at least 300 line pairs in the long dimension.

(4) The camera should be able to record a ½ electron volt temperature blackbody source at a reasonable density during the shutter exposure time. This corresponds to a blackbody temperature of about 6000 K.

(5) The camera should be self-contained and portable.

A Kerr cell designed and manufactured by Electro-Optical Systems, Inc., was chosen for the shutter on the basis of short exposure time, small jitter, good cell transmission and a high total of information points transmitted through the cell aperture within the tolerated viewing angle. This cell has a "shutter open" time of 5×10^{-9} sec, so the optical delay path increment was fixed at 1.5×10^{-8} sec, corresponding to a framing rate of 6.7×10^7/sec.

The complete unit as designed is a six-frame camera, $f/10$ to the film plane. System transmission for the longest path is around 17% at 5000 A, including the absorption losses in the Kerr cell and polarizing filters. Individual frames are 6 by 15-mm; at 40 lines/mm expected resolution, each frame has 240 by 600 information lines content. The delay unit is 96 in. long, 40 in. wide and 40 in. high. It is mounted on wheels and will weigh about 400 lb.

Figure 1 illustrates the optical layout. Plane 1 is the point at which all six lines of sight form a first image. These images are formed by an interchangeable objective assembly whose design depends upon the type of event being watched.

Plane 1 is also the point of entry into the relay system. This system delivers a similar set of images to Plane 2, but with varying time-of-flight delays.

Plane 2 represents the point of exit from the relay system for each line of sight. All six lines of sight form coplanar contiguous images that are photographed on a single film Plane 3 through the Kerr cell.

The camera lens is located against the Kerr cell and views the composite image directly. A reflex mirror viewfinder is coupled with the lens for viewing the film plane image. A 35mm camera with a 125mm lens and associated reflex housing is used.

Three interchangeable objective assemblies are contemplated:

(1) A set of six 48mm microscope objectives are mounted in close array on the circumference of a 48-mm radius circle with the event at the center. The axis of viewing symmetry and high magnification find obvious application to exploding wire studies.

(2) A single objective of aperture $f/4$ or wider forms an aerial image from which six $f/10$ beams are split off

Presented on October 20, 1960, at the Fifth International Congress on High-Speed Photography at Washington, D. C., by Willis C. Goss, University of California, Lawrence Radiation Lab., Livermore, Calif.

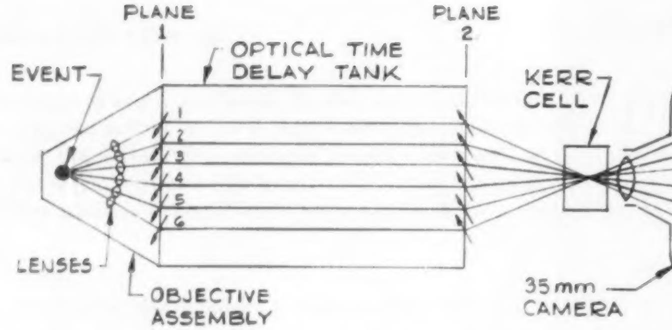

Fig. 1. Optical flow diagram.

for entry into the delay system. This will be useful for large-yield hydrodynamic shots. A variety of objective focal lengths will be provided.

(3) Six long-focus telescopes will be mounted together in a bundle to provide shot capability for large-scale distant events.

Relay of images is accomplished by the use of three spherical mirrors working at 1:1 conjugates and off-axis an amount adequate to clear the original image. The mirror radii are one half the time delay path required for the 2nd, 3rd and 4th paths; i.e., 88½ in., 177 in., and 265½ in., respectively. The fifth and sixth paths are made up by consecutive traversal of the appropriate shorter mirror paths.

Figure 2 illustrates the 2nd, 4th and 5th optical delay paths. Note that the fifth path utilizes the 2nd and 4th paths consecutively.

Since the resolution requirement is a fairly exacting one, the image is relayed at a large size, then demagnified for recording at the film plane. A demagnification of 8 was arrived at partially because of a desire to keep relay mirrors and field mirrors the same size.

The choice of spherical mirror optics to perform the relay function was made because of the need for a truly achromatic aplanatic image to preserve resolution over these long distances.

Controlling and synchronizing electronics employ the usual coaxial cable delays with the Kerr cell triggered in parallel or tandem with the event, depending upon the relative inherent delays in the two circuits.

A four-frame working model has been put together using components from the as yet unassembled six-frame camera. An exception to this was the field lenses which were not yet available. Smaller lenses that were on hand were substitutes.

Results were excellent. The relayed images formed by the spherical mirrors exhibit 10 lines/mm and so the film plane images are limited by the camera lens and film grain. Considerably better than 40 lines/mm are being had on Panatomic X film.

Figures 3 and 4 show a number of sequences photographed with the four-frame model. Figure 3(A) is a static setup showing the nibs and wire on the end of a bridgewire. The wire is 0.001 in. in diameter and 0.100 in. long. Note the foreshortening effect on the nibs; this is due to the necessarily different viewing angle from which each picture is taken. Pictures 2 and 3 in Fig. 3(A) have the maximum angular separation, which is about 90°. Figures 3(B), (C) and (D) are sequence pictures, from bridgewires in the early stages of their expansion. Figures 4(A)—(C) are pictures of bridgewires that were slightly bent before firing, and in Fig. 4(D) the bridgewire is one that had been bent into an "S" shape.

Results from the four-frame model have been so encouraging that we plan to modify the six-frame camera design into an optional 12-frame system by providing a 50% beam splitter that can be inserted into place immediately ahead of the six-frame composite image and then relaying the reflected light as a single picture for an additional delay of 9×10^{-8} sec. This composite image will be re-formed immediately above the original group of six so that all twelve may be imaged together onto the same film plane.

Further development in the direction of faster framing rates only awaits development of a faster voltage switching device. Mechanisms are known that can switch in times of the order of 10^{-10} sec,[6] but the jitter problem has not yet been solved. The dielectric relaxation time is also of the order of 10^{-10} sec[7] and it appears that the Kerr cell geometry and circuitry could be altered so as to provide a time constant very nearly down to 10^{-10} sec.

The optical delay systems to go with such faster framing rates are smaller and more easily packaged, of course. As pulsed image converters are improved to give useful light gains at reasonable resolution values development of very sensitive time delay framing systems for use under relatively low illumination levels can become a reality.

Credits are due several people from the Lawrence Radiation Laboratory. LeRoy Gilley contributed extensively with numerous suggestions, in helping choose the optical layout and by making and operating a number of system mockups. Irene Dusina and J. Rockwell Smith

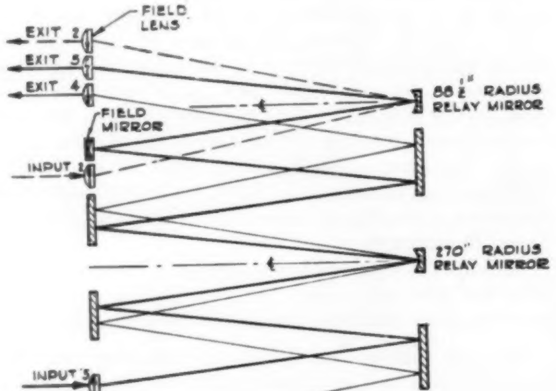

Fig. 2. No. 5 path using the No. 2 and No. 4. paths.

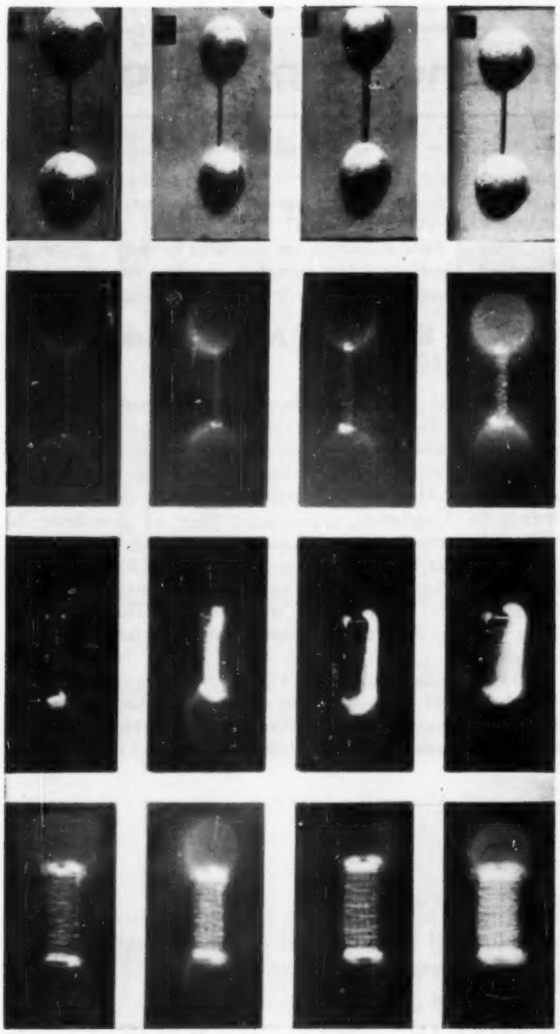

Fig. 3. Exploding bridgewire sequences.

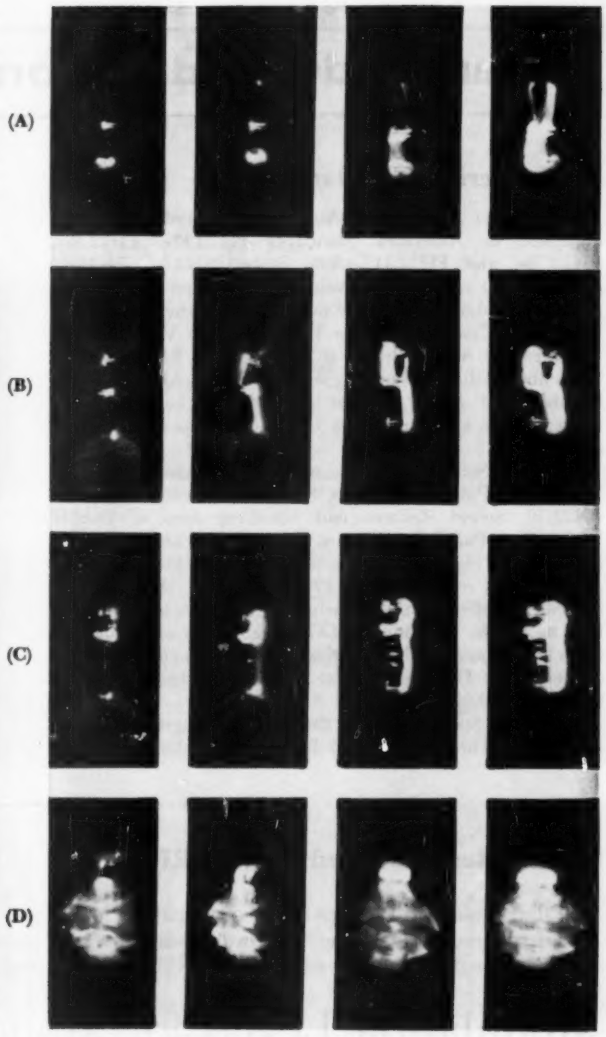

Fig. 4. Exploding bridgewire sequences.

are responsible for the mechanical layout, design and drafting.

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Résumé

Une caméra multi-images à cellule Kerr

Willis C. Goss, Lawrence Radiation Laboratory, University of California, Livermore, Californie

L'auteur décrit le type de construction d'une caméra multi-images de grande vitesse à cellule Kerr. On utilise une seule cellule Kerr, à pulsation unique, en combinaison avec un système de retards optiques pour produire six images consécutives à des temps entre images de 1,5 $\times$ 10^{-8} s et des temps d'exposition de 5 $\times$ 10^{-9} s. La caméra est $f/10$ au plan de film de 35 mm et les images ont approximativement un contenu de 150 $\times$ 450 lignes informatrices. On prévoit que l'énergie de seuil des images à la source sera une température effective de corps noir de $\sim\frac{1}{2}$ ev pour du film Tri-X. On compte que cette caméra trouvera des applications considérables dans les études de fils explosants, ainsi que dans l'hydrodynamique des explosifs extra-puissants.

Zusammenfassung

Bildreihenkamera mit Kerrzelle

Willis C. Goss, Lawrence Radiation Laboratory, University of California, Livermore, Kalifornien

Es wird die Konstruktion einer Hochgeschwindigkeits- Bildreihenkamera mit Kerrzelle beschrieben. Es wird eine einzige Kerrzelle mit Einzelimpuls in Verbindung mit einer Anordnung von optischen Verzögerungen angewendet um sechs aufeinanderfolgende Bilder mit Zwischenbildintervallen von 1,5 $\times$ 10^{-8} Sekunde und Belichtungszeiten von 5 $\times$ 10^{-9} Sekunde zu erhalten. Die relative Öffnung ist 1:10 auf der 35 mm Filmfläche und die Bilder haben einen Inhalt von ungefähr 150 $\times$ 450 Informationslinien. Die Schwellenenergie der Bildquelle wird voraussichtlich bei einer wirksamen Schwarzkörpertemperatur von $\sim$0.5 ev für Tri-X Film liegen. Man hofft, dass die Kamera weite Verwendung bei Studien mit explodierenden Drähten und in der Hochenergie-Explosions-Hydrodynamik finden wird.

Ed. Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

standards and recommended practices

Four American Standards

On October 28, 1960, the American Standards Association approved as American Standards PH22.52-, PH22.69-, PH22.70-, and PH22.117-1960. Since PH22.52, PH22.69 and PH22.70 reflect no technical change from the versions previously published, they are not being published here.

PH22.52, Cross-Modulation Tests for 16mm Variable-Area Photographic Sound Prints, is a revision of PH22.52-1954. The standard differs from the previous version, published in the October 1954 *Journal*, in that the title was changed and a reference, the source of which is now out of print, has been deleted.

PH22.69, Sound Records and Scanning Area of Double Width Push-Pull Sound Prints, Normal Centerline Type, and PH22.70, Sound Records and Scanning Area of Double Width Push-Pull Sound Prints, Offset Centerline Type, are revisions of 1948 standards, published in the November 1948 *Journal*, and reaffirmed in 1953. Although the technical content is unaffected, the following changes have been made in both standards: (a) addition of a scope and table of dimensions, (b) clarification of the drawing. The millimeter tolerance conversion of Dimension H in PH22.69 has been corrected from 0.05 to 0.02.

PH22.117, Spectral Diffuse Density of Photographic Sound Record on Three-Component Subtractive Color Films, was published in the December 1959 *Journal* for trial and comment, and has been adopted as an American Standard without change since trial publication.

Copies of these standards are available from the American Standards Association, Incorporated, 10 East 40 St., New York 16, at a nominal cost.—*J. Howard Schumacher*, Staff Engineer

Proposed Revision of American Standard PH22.94–1954

A proposed revision of American Standard Slides and Opaques for Television Film Camera Chains, PH22.94-1954, is published here for a three-month period of trial and criticism.

The Television Committee began their study of the subject standard in April 1959 in accordance with the American Standards Association requirement that all standards be reviewed every five years. This proposal, approved by the Television and Standards Committees, differs from the 1954 standard in that Sections 1.1 and 1.2 have been reworded to further clarify the intent of the standard. The change in Note 1 reflects the omission of the reference to the thickness of opaques.

All comments should be sent to the Staff Engineer prior to March 15, 1961. If no objections are received, the proposal will then be submitted to ASA Sectional Committee PH22 for further processing as an American Standard.—*J.H.S.*

SMPTE Recommended Practice RP 6*

This Recommended Practice originated in the Video Tape Recording Committee. The proposal, approved by the initiating committee and the Standards Committee, was published for trial and comment in the April 1960 *Journal*. The recommendation received final approval by the Society's Board of Governors on October 16, 1960.

Modulation Levels for Monochrome 2-Inch Video Magnetic-Tape Recording

Introduction. In current video-tape recording systems the playback video signal level is dependent upon two independent factors, viz., (a) adjustment of the playback video amplifier gain setting and (b) deviation of the recorded, frequency-modulated, radiofrequency carrier signal. In order to achieve uniformity of playback video signal levels without the accompanying need for readjustment of the playback video amplifier gain, it is essential that all video-tape recordings be made in accordance with the same recommended practice for carrier deviation. This is of particular importance for playback on equipment other than that used for recording, or when the playback tape consists of two or more recordings spliced together.

Recommendations

1. *Scope*

1.1 This recommended practice specifies the recorded modulation levels for monochrome television signals.

2. *Recorded Carrier Frequencies*

2.1 The recorded carrier frequencies corresponding to reference video signal levels shall be as follows:

(a) Reference White Level: 6.8 ± 0.05 mc.
(b) Blanking Level: 5.0 ± 0.05 mc.
(c) Sync Tip Level: 4.28 ± 0.05 mc.

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* A copy of this Recommended Practice may be obtained without charge upon request directed to J. Howard Schumacher, Staff Engineer, at SMPTE headquarters.

Proposed American Standard

Slides and Opaques for Television Film Camera Chains

Revision of PH22.94-1954

Supplement to Z38.7.19-1950

1. Scope

1.1 This standard is intended to guide those preparing slides and opaques for conventional program usage in television transmission. The standard applies only to slides and opaques intended for transmission in the standard fashion via a film camera chain. For other applications, such as background projection, the usual television requirements may not apply.

1.2 This standard is not intended to apply to standard test slides which must have tighter dimensional tolerances in order to facilitate the setup and adjustment of television film chains.

2. Dimensions

2.1 Nominal Size. Only the four nominal sizes listed in Column 1 of the table shall be considered standard for use in television film camera chains.

2.2 Overall Dimensions. The overall dimensions for any nominal size shall comply with the dimensions tabulated in Column 2. (See Note 1.)

2.3 Dimensions of Transmitted Picture. The portion of the slide or opaque intended for transmission shall lie within a centrally located rectangle having the dimensions shown in Column 3. (See Note 2.)

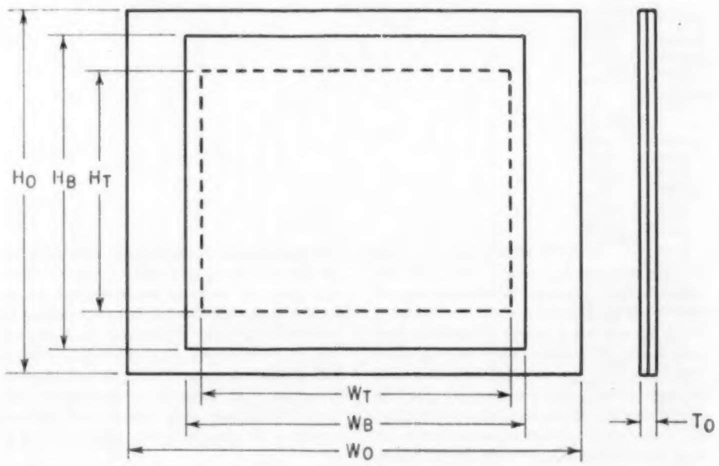
2.4 Dimensions of Picture Background. The background (or the pictorial material) of the slide or opaque shall extend without interruption over a centrally located rectangle having the dimensions shown in Column 4. (See Note 3.)

2.5 Centering Tolerance. The center of the transmitted picture rectangle and the center of the background rectangle shall both lie within a circle having as its center the center of the slide and as its radius the dimension tabulated in Column 5.

Note 1. This standard is intended to supplement American Standard Dimensions for Lantern Slides, Z38.7.19–1950, by including additional specifications required by the television system.

Note 2. The dimensions shown for the transmitted picture are those which will be scanned by a perfectly adjusted film camera chain. To allow for some misadjustment of the film camera chain and an additional misadjustment in the home receiver, it is recommended that all essential information be contained in a centrally located area appreciably smaller than that specified in column 3.

Note 3. In the case of slides, the background rectangle should be defined by an opaque mask to limit the stray light entering the film camera chain. The dimensions specified in Column 4 permit the use of masks which comply with Z38.7.19–1950. For opaques, masking is generally provided by the projection equipment.



Col 1 Nominal	Col 2 Overall H_o		Col 2 Overall W_o		T_o max	Col 3 Transmitted Picture H_T max	W_T max	Col 4 Picture Background H_B min	W_B min	Col 3 Centering Tolerance
2 × 2 slide (double 35)	2	$^{+0}_{-1/32}$	2	$^{+0}_{-1/32}$	$1/8$	$27/32$	$1\,1/8$	$29/32$	$1\,11/32$	$1/64$
$3\,1/4$ × 4 slide	$3\,1/4$	$^{+1/64}_{-1/32}$	4	$^{+1/64}_{-1/32}$	$5/32$	$2\,1/16$	$2\,3/4$	$2\,3/4$	3	$3/64$
$4\,1/4$ × 4 opaque	$3\,1/4$	$^{+1/64}_{-1/32}$	4	$^{+1/64}_{-1/32}$	$1/32$	$2\,1/16$	$2\,3/4$	$2\,3/4$	3	$3/64$
4 × 5 opaque	4 ± $1/32$		5 ± $1/32$		$1/32$	3	4	$3\,3/16$	$4\,1/4$	$1/16$

All dimensions are in inches

American Standard

Spectral Diffuse Density of Photographic Sound Record on Three-Component Subtractive Color Films

ASA
Reg. U.S. Pat. Off.

PH22.117–1960

Supplement to PH2.19-1959 and PH2.1-1952

*UDC 535.36:778.534.4:778.66

INTRODUCTION

The American Standard Spectral Diffuse Densities of Three-Component Subtractive Color Films, PH2.1-1952, which applies primarily to picture on color film, constitutes the basis for this standard, and Sections 2, 3 and 4 of that standard are to be considered part of the present standard.

The purpose of this standard is to supplement the American Standard Spectral Diffuse Densities of Three-Component Subtractive Color Films, PH2.1-1952, by specifying spectral conditions suitable for determining the sensitometric characteristics of photographic sound record on three-component subtractive color films. The conditions of this standard are intended for, and are applicable to, systems of sound reproduction using the S-1 photosurface, since this photosurface is in common use at the present time. It is recognized that there are other types of photosurfaces sometimes used for photographic sound reproduction that do not fall within the scope of this standard.

In three-component subtractive color films, dyes or color couplers are used to form the photographic image. These color materials are designed primarily for the visual region, but sound-record reproduction via the S-1 photosurface uses the infrared region of approximately 700 mμ (millimicrons) to 900 mμ, which is far enough away from the visual region so that the color materials cannot be used efficiently, but close enough so that they produce a measurable effect. The spectral characteristics of this effect depend on the type of light-absorbing material used for the sound record, and on the manner in which the sound record is processed. Therefore, in order to obtain uniformity of sound record densitometry among different films, and among the different density measuring instruments, it is necessary to specify the spectral conditions under which these density measurements are made. It is the aim of this standard to define these conditions sufficiently to insure reasonable uniformity of density measurements, yet not so rigidly as to make impractical the obtaining of such measurements.

This standard defines a primary condition which shall be the ideal method of taking density measurements of sound record on subtractive color films. This standard also defines a practical condition by means of which it is expected that most density measurements will be made.

If the accuracy required is less than that provided by the practical condition, it does not seem economical to use an instrument designed specifically for sound record. An instrument which measures in the visual region, perhaps with minor modifications to favor the general infrared region, will suffice.

1. Purpose and Scope

1.1 The principal purpose of this standard is to supplement American Standard Diffuse Transmission Density PH2.19-1959, and, further, to supplement American Standard Spectral Diffuse Densities of Three-Component Subtractive Color Films, PH2.1-1952.

1.2 This standard defines conditions suitable for integral spectral density measurement of photographic sound record on three-component subtractive color films.

1.3 It is recognized that there are other useful types of photographic sound-record density measurements that do not fall within the scope of this standard.

2. American Standard Diffuse Density

2.1 The following sections of the American Standard Diffuse Density PH2.19-1959, are part of the American Standard Spectral Diffuse Density of Photographic Sound Record on Three-Component Subtractive Color Films:

2. General Definition of Density

3. Totally Diffuse Density

4. American Standard Diffuse Density

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3. American Standard Spectral Diffuse Densities of Three-Component Subtractive Color Films

3.1 The following section of the American Standard Spectral Diffuse Densities of Three-Component Subtractive Color Films, PH2.1-1952, is part of the American Standard Spectral Diffuse Density of Photographic Sound Record on Three-Component Subtractive Color Films:

2. Terminology Used in the Densitometry of Color Film

4. Terminology Used in the Densitometry of Photographic Color Sound Records

4.1 *Peak Response.* The peak response of a densitometer is the wavelength to which the densitometer has the greatest response, including such factors as the spectral emission of the light source, the combined spectral transmission of all optical filters in the light path, and the spectral sensitivity of the photosensitive receptor.

4.2 *Bandwidth.* The bandwidth of a densitometer is the range of wavelengths to which the densitometer is sensitive. In a practical densitometer this range of wavelengths is not sharply defined; but for the purposes of this standard, the bandwidth shall be considered to lie between those wavelengths which excite, in the photosensitive receptor, one-half the current which is excited at the wavelength of peak response. These limiting wavelengths are to be measured or computed using the light source, all operating optical filters, and the photosensitive receptor of the densitometer.

4.3 *Overall Response.* The overall response of a densitometer is the integrated response of the densitometer to all wavelengths, including such factors as the spectral emission of the light source, the combined spectral transmission of all optical filters in the light path, and the spectral sensitivity of the photosensitive receptor.

5. Potassium Infrared Diffuse Density

5.1 Potassium infrared diffuse density is diffuse density measured with energy concentrated in the spectral doublet of wavelengths 766.5 and 769.9 mμ of a potassium arc.

6. American Standard Spectral Density of Photographic Sound Record on Three-Component Subtractive Color Films

6.1 American Standard spectral diffuse density of photographic sound record on three-component subtractive color films is American Standard diffuse transmission density measured in any practical instrument with any practical condition which is proven by test to yield densities not significantly different from potassium infrared diffuse density, providing that the peak response of such a practical instrument is 768 ± 5 mμ, that the bandwidth of such an instrument is 20 mμ or less, and that the response of such instrument within the band from 758 to 778 mμ is at least 80 percent of the overall response.

The Fifth International Congress on High-Speed Photography

TWO YEARS OF Society activity preceded the Congress held on October 16–22, 1960. The first major planning began during the Society's Convention at Detroit in October 1958. The chronicle of the Fifth Congress in the *Journal* began in the August 1959 issue (p. 550) with the announcement of key chairmen and general plans. These were Max Beard, Chairman of the Congress—to be assisted by Richard O. Painter as Associate Papers Program Chairman, J. S. Courtney-Pratt as Associate Program Chairman for Papers From Abroad, and James A. Moses as Associate Program Chairman in Charge of Film Showings.

Subsequent reports appeared in the issues of September 1959 (p. 638); October 1959 (p. 706); November 1959 (List of Topic Chairmen beginning on p. 771); December 1959 (p. 839); January 1960 (p. 49); February 1960 (p. 122); April 1960 (p. 247); July 1960 (an extensive report on the organization of the Fifth Congress beginning on p. 489); August 1960 (p. 548); and September 1960 (Advance Program beginning on p. 609).

The gathering together of topflight scientists from all over the world, under the auspices of the SMPTE, was an event of international importance, recognized by the United States government by its support of the Fifth Congress and expressed in the resolution introduced by Senator Warren C. Magnuson (*Journal*, October 1959, p. 706, and April 1960, p. 274), and in a welcoming letter by President Eisenhower to SMPTE President Norwood L. Simmons.

Committee of Honor

A special feature of the Fifth Congress was the appointment by President Simmons of a Committee of Honor. Some of the greatest names in science—men representative of the caliber of the individuals who are making history in the many fields of science were appointed. Those on the Committee of Honor were: Detlev W. Bronk, President, National Academy of Sciences; John M. Clark, General Manager, Photo Products Dept., E. I. du Pont de Nemours & Co., Inc.; Edward P. Curtis, Vice-President, Eastman Kodak Co.; Donald W. Douglas, Sr., Chairman, Board of Directors, Douglas Aircraft Co.; Harold E. Edgerton, Dept. of Electrical Engineering, Massachusetts Institute of Technology; James B. Fisk, President, Bell Telephone Laboratories, Inc.; T. Keith Glennan, Administrator, National Aeronautics and Space Administration; G. K. Hartmann, Technical Director, U.S. Naval Ordnance Laboratory; Theodore Von Karman, Chairman, Technical Advisory Board, Aerojet General Corp.; James R. Killian, Jr., Chairman of the Corporation, Massachusetts Institute of Technology; Paul E. Klopsteg, Chairman, Board of Directors, American Association for the Advancement of Science; William H. Pickering, Director, Jet Propulsion Laboratory, California Institute of Technology; Simon Ramo, Executive Vice-President, Thompson Ramo Wooldridge Inc.; C. Guy Suits, Vice-President, General Electric Co.; Herbert F. York, Director of Defense Research and Engineering, Department of Defense.

Organization of the Congress

Compared with the usual SMPTE Semiannual Convention, the Congress was larger, longer and in many other ways different; however, the successful staging of the Congress owed much to its being administered in a way corresponding as much as possible to the Society's convention procedures which were the responsibility of Reid H. Ray, Convention Vice-President in 1959–60. The organization of the papers program was under Editorial Vice-President Glenn E. Matthews.

The responsibility of the Fifth Congress Arrangements Committee, doubly heavy, was carried out with the apparent smoothness that is achieved only by hard work and meticulous planning. Byron Roudabush was Arrangements Chairman.

The special efforts to make a large international congress were made possible by a government grant to complement the Society's usual activities for a Semiannual Convention. The liaison and special planning were accomplished for the Society by Wilton R. Holm, then Secretary of the Society; Ethan M. Stifle, Financial Vice-President; and Max Beard, Chairman of the Congress. The support given by the Department of Army, Navy and Air Force was administered by the Chief Signal Officer of the Army. Admiral Robert S. Quackenbush, Jr., was Government Liaison Chairman.

The Arrangements Committee Chairmen appointed by Messrs. Roudabush and Ray were chiefly experienced Society workers. Howland Pike handled registration

D. Max Beard, Chairman of the 5th Congress, receives a Certificate of Appreciation from Norwood L. Simmons, SMPTE President.

Members of the Committee of Honor. Left to right: Harold E. Edgerton, Massachusetts Institute of Technology; John M. Clark, General Manager, E. I. du Pont de Nemours & Co.; G. K. Hartmann, Technical Director, U. S. Naval Ordnance Laboratory; Paul E. Klopsteg, Chairman of the Board of Directors, American Association for the Advancement of Science.

smoothly and efficiently. Hospitality activities were the responsibility of Chairman Fred W. Gerretson. Entertainment was under the auspices of Dean F. Lawson and banquet arrangements were handled by Dudley Spruill. Hotel arrangements were handled by Arthur Rescher. Nathan D. Golden was Reception Chairman. Stuart Cameron was Publicity Chairman. The Ladies Program was arranged by Henry M. Fisher. Mrs. Keith Lewis and Mrs. Garland C. Misener fulfilled the duties of hostess with competence and charm.

Projection and Public Address and Recording — areas in which "slip ups" are prone to occur — were in the capable hands of Wilson E. Gill and J. Clinton Greenfield. Transportation arrangements were made by Jack Jiruska. Frank Havlicek was Administrative Assistant during Congress week. The auditor was Charles E. McGown, assisted by Mrs. C. B. Smith of Byron Motion Pictures, Inc. The Awards Session (described later in this issue) was arranged by Joseph E. Aiken. Keith Lewis was Exhibits Chairman. Joyce Towles and Mrs. Ruth Ashton were on hand to expedite secretarial and other matters for Messrs. Roudabush and Ray.

Interpretation

One of the special services to be supplied by the Congress planners was that of interpretation. Garland C. Misener, as Interpretation Chairman of the Congress Arrangements Committee, handled the multifaceted problem skilfully. An expert from Georgetown University, Dr. Stefan Horn, was chosen to supervise the simultaneous interpretation of all technical papers into the three official languages of the Congress, English, French and German. Copies of each author's paper were studied beforehand by the translators to permit their simultaneous delivery in the two languages other than the author's, then simultaneous interpretations were given for all the discussion following a paper. Prof. Horn also provided the three teams of interpreters at work during all sessions. Individual transistorized 4-channel radio receivers were issued to each registrant to permit him to "tune in" the language he preferred. An additional channel was used for directly tuning in the speaker, moderator, or voice from the floor. About 800 units of the IBM wireless equipment were used.

Of special assistance in this part of the program, as well as in preceding months, was Mrs. Lena Mans, of the Naval Ordnance Laboratory. She coordinated the manuscripts and supplied copies for the interpreters. She also assisted with copies for the press room and helped authors and Dr. Horn whose work and efforts went beyond the call of duty.

Closed-Circuit

Another useful feature of the Fifth Congress was the use of a closed-circuit television system. Monitors were placed in suitable locations throughout the hotel, including near the Registration Desk and in the Exhibit Area, so that delegates and visitors could be informed at any time as to what paper was being presented. The equipment was made available through the courtesy of Walter Reed Army Hospital. Lewis Blair was Closed-Circuit TV Chairman.

Some Special Assistance

Considerable credit for the smoothness of the functioning of the technical sessions is also due R. T. Van Niman who, without formal title, coordinated the mechanical aspects of the work of the Sessions Vice-Chairmen. Also, Ed Beckman, projectionist, spent the entire week, day and night, projecting motion pictures and slides, managing matters to obtain smooth operation and accomplish the speakers intent. Miss Lisa Löper supervised and coordinated the procurement of the discussion questions and contributions supplied written on a special form for the Congress.

Photographs of the Congress have been supplied through the extensive and helpful efforts of scientific photographers from the Naval Ordnance Laboratory: Roy Simpson, John Arena and Francis Smith.

Motion-picture footage of the Congress was shot by William E. Youngs of the U.S. Information Agency. It is being edited and prints made by Reid H. Ray.

Development of the Papers Program

Begun nearly two years ago was an intensive correspondence campaign by Chairman Beard, who is Chief of the Photographic Division of the Naval Ordnance Laboratory. This correspondence not only solicited papers for the program but also generated interest in the Congress among government research personnel throughout the country, and in universities and industry.

Dr. J. S. Courtney-Pratt, in his capacity as Associate Program Chairman for Papers From Abroad, corresponded with more than 900 individuals in all parts of the world outside the U.S. It was largely due to his efforts that nearly half the 106 papers and film presentations on the program came from overseas and Canada.

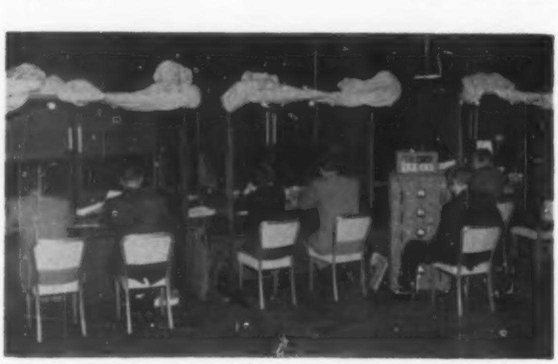
More than 5000 copies of a four-page announcement with general information about the Congress were sent out early in 1960. Nearer the Congress date some 17,000 copies of a handsome 20-page brochure, in two colors, containing full details and including a summary of the technical program and registration forms for the Congress, were distributed far and wide. Besides all members of SMPTE, the members of the Society of Photographic Scientists and Engineers received this brochure, which was produced in Washington under the able direction of Byron Roudabush, with text supplied by Max Beard and others.

The SPSE Symposium on Rapid Processing was briefly announced in this brochure.

Assisting Mr. Beard on the Technical Program Committee, besides J. S. Courtney-Pratt who has the continuing responsibility of Editorial Chairman for the *Congress Proceedings*, were Richard O. Painter, Associate Papers Program Chairman; Morton Sultanoff, Associate Program Chairman for Congress Sessions; and James A. Moses, Associate Program Chairman in Charge of Film Showings.

National Delegates

Papers from foreign countries were solicited by the fifteen National Delegates, each an internationally recognized authority in his field. The Delegate from Belgium was Dr. Franz Topfer; from Canada, Alexander Easson; Czechoslovakia, Vaclav Kolar; France, Ing. Mil. en Chef de 1°Cl. P. Fayolle; Germany, Prof. Dr.-Ing. H. Schardin; Greece, Prof. Dr. P. Santorini; India, Dr. Kartar Singh; Israel, G. Nahmani; Japan, T. Uyemura; Netherlands, Dr. J. G. A. de Graaf; Norway, Kaye Weedon; Sweden, Civ.-Ing. Tryggve Ramqvist; Switzerland, Prof. Dr. J. Eggert; Union of Soviet Socialist Republics, Dr. A. I. Tchernyi; United Kingdom, Dr. R. F. Saxe.



The teams of simultaneous interpreters at work in their booths overlooking the session auditorium.

Max Beard, 5th Congress Chairman (right), and Dr. Schardin, Chairman of the 4th Congress (left), talk with Dr. J. G. A. de Graaf, Chairman of the 6th Congress.

Topic Chairmen

Topic Chairmen for Solicitation of Papers in the United States were Robert Betty, Willard E. Buck, Lincoln L. Endelman, William C. Griffin, Guy H. Hearon, Jr., William G. Hyzer, Glen H. Jones, John H. Niemeyer, Harry L. Parker, Nelson W. Rodelius, Loren E. Steadman, Morton Sultanoff, Vernon E. Taylor, John H. Waddell, Willett R. Wilson, Charles W. Wyckoff and A. M. Zarem.

For scheduling the papers in sessions and for carrying out the timing of the sessions a great deal of credit is due Morton Sultanoff.

National Delegates to the 5th Congress. Front row, left to right: Ing. Mil. en Chef de 1e Cl. P. Fayolle, France; Dr.-Ing. Hubert Schardin, West Germany; D. Max Beard, United States; Dr. A. I. Tchernyi, Union of Soviet Socialist Republics. Back row: Dr. P. Santorini, Greece; Dr. R. F. Saxe, United Kingdom; Dr. Franz Topfer, Belgium; Alexander Easson, Canada; Civ.-Ing. Tryggve Ramqvist, Sweden; Dr. J. G. A. de Graaf, Netherlands; Kaye Weedon, Norway: Nikolai Zandin, Union of Soviet Socialist Republics.

Technical Program

From a report by Berlyn Brixner

The uniformly high caliber of the papers and the excellent arrangement of the Sessions make it difficult to single out any Sessions or group of papers as "outstanding" or to point to one more than another as representative.

The meeting was especially notable for its very broad coverage of the field, along with the presentation of some real advancements.

The bulk of some 106 papers and film presentations at the technical sessions came, as would be expected, from the U.S.A. In order of numbers, other papers came from England, France, Germany, Belgium, Switzerland, Czechoslovakia, and Japan. Proposed papers from India and Australia had interesting titles but were presented only by abstract. Some seven papers from Russia were summarized in a special presentation by Dr. A. I. Tchernyi arranged for the end of Friday morning's Session. It is expected that several of these papers will be published in full, others as abridgments. They will appear in the Congress *Proceedings*, and some may also soon appear in the *Journal*.

The largest class of papers was that which reported the application of high-speed motion-picture photography to industrial engineering investigations and to basic scientific research. In these studies the framing rates ranged from a few hundred to a few million frames per second. The lower speeds were used to study canning machinery, outboard marine operation, coal pulverizing machinery, and atomic reactor engineering mechanisms. Speeds in the thousands of frames per second were used for the study of underwater pneumatic and spark sound generators and, especially, for macrophotography of such subjects as the action of a metal-cutting tool and the bubble formation in a liquid. Macrophotography studies of liquid sprays, fuel atomizers, and cellulose fiber suspensions required similar frame rates but a much shorter exposure time. The shortest exposure times and highest speeds were required for studies of exploding wires, dynamic strains in opaque materials (using photoelastic coatings), stereoscopic studies of shaped-charge-liner jet formations, the shock loading and compressibility of solids, the structure of ultrasonic air jets, liquid/solid impacts, hypersonic flow (using a differential interferometer), and the expansion of turbulence areas in gaseous shock phenomena. Two novel ballistic studies pointed the way toward more extensive applications of old velocity synchronization techniques.

A mechanism was described which increases the frame rate of intermittent pin-registration cameras to a maximum of 9600 pps. A break-through in rotating-mirror frame cameras gives a practical method of focal plane shuttering which permits a very short exposure time without loss of aperture in the million-frame-per-second range. A portable million-frame-per-second camera with twelve frames has been developed.

The cameras of highest time resolution are the rotating-mirror sweeping-slit type. Intensive study of these has resulted in significant gains. Outstanding was an $f/1$ streak camera, especially for the study of sparks, with reflection optics for use in the ultraviolet or visible. Two other designs described had reflection optics of small aperture. Several papers described cameras of conventional but refined design. One paper revealed some novel properties of beryllium for radically diminishing the surface distortion of rotating mirrors.

The Kerr cell shutter has been improved by the development of superior control circuits which permit, in one case, repetitive and, in another, more efficient cell pulsing and better synchronization with flashtube light sources, especially for reflected light photography. The image-converter tube, although it has been subject to development, continues to have low overall resolution potentialities at the highest speeds. However, there is considerable progress in the use of some classes of these tubes for image intensification, and claims have been made for enormous light gains in certain applications. For instance, the intensifiers have been used successfully with flash x-ray techniques. And a novel optical scheme for intensifying underexposed negatives was described.

A number of papers described the production and use of improved light sources. There were reports (1) on new measurements of the characteristics of spark gaps and gaseous discharge lamps; (2) on intense, short-duration light flashes with surface brilliance up to perhaps one hundred times the Sun's brightness and time durations shorter than a hundred millionth of a second; and (3) refinements in controlling the electric power exciting the lamps, which refinements make possible the above-mentioned amazing light outputs. Long-duration explosive light sources have been improved in ease of fabrication and constancy of illumination. There were reports on several novel applications of these lights to the photographic solution of research problems.

Remote-control operation of high-speed cameras was the subject of papers describing part or all of the facilities at such American, British and French research centers as the Argonne National Laboratory, the Lawrence Radiation Laboratory, Aberdeen Proving Ground, the U.S. Naval Ordnance Test Station, the Atomic Weapons Research Establishment, the National Physical Laboratory, and the Laboratoire Central de l'Armement. Reports on these facilities continued on down the line to unit installations for the operation of rotating-prism cameras, including both an underwater installation and a clever speed control permitting several runs per film roll; and the reports covered such control equipment details as automatic speed control for rotating-mirror turbine drives, a pulse program generator adjustable over an enormous range, and a quenched spark gap repetitive trigger scheme.

Flash x-ray equipment has been increased in power, in one case to the megavolt range. Emphasis was on repetitive high-powered pulsing to produce a series of images at rates up to 12,000 per second. Several applications of these techniques were described.

Outstanding among sensitive materials is a direct-recording paper on which the latent image, formed by high-intensity light, is developed by exposure to low-intensity light. The speed of the paper makes possible fast recording with vibrating

Crawford H. Greenewalt, President, E. I. du Pont de Nemours & Co., guest speaker at the Congress Opening.

mirror oscillographs. In addition, valuable information was given about the forced development of various high-speed films; and there were reports on two new studies of reciprocity failure.

Valuable for the researcher who uses photographic instrumentation were reports on the interpretation uncertainties, information content, resolution limits, and even on the economic savings resulting from high-speed photography.

The technical papers program was for practical purposes complete and in order as published in the September *Journal*, pp. 609–682. The Final Program also showed the Session-opening short films, Session Chairmen, and the exact delivery time for each paper.

An atypical Session, but one of unusual popular interest, took place Friday evening and consisted of films showing medical and biological applications of high-speed photography. The Session opened with a film on Blood-Cell Measurement presented by A. M. P. Brookes, Dept. of Engineering, University of Cambridge, for Dr. P. A. C. Monro, Anatomy School, University of Cambridge, England. A film on High-Speed Photography in Medical Research by E. S. Gurdjian, H. R. Lissner and L. M. Thomas, neurological surgeons, of Detroit, was presented by Dr. Thomas. One sequence of the film showed a human cadaver dropped onto a sheet of plate glass, with records obtained of the fall at 16 frames/sec and again at 1500 frames/sec. The audience could see quite plainly the breaking of the glass and the movements of the head striking the glass. Some interesting points about rigor mortis were brought out during the discussion.

Irving Rehman, a consultant to the Oceanic Research Division of the Naval Ordnance Test Station, presented a film on Photographic Problems, Techniques and Instrumentation in Sea Animal Locomotion Studies. The sea animal chosen for study was the porpoise, an animal of almost alarming intelligence. Trained to swim upon signal through a long, narrow, shallow tank, the porpoise was photographed by high-speed cameras which recorded velocity, acceleration, drag, behavior patterns and characteristic segmental and sequence movements.

An extremely interesting film presented by Eric Lucey of the Dept. of Animal Genetics, University of Edinburgh, Scotland, showed motion-pictures of vocal cords.

Films, Session Opening Short Subjects

In addition to the films shown as part of the Technical Sessions, an extraordinary and appropriate collection of short films shown at the beginning of various Sessions was a tribute to the devoted efforts and ability of the Associate Program Chairman in Charge of Film Showings, James A. Moses.

The Monday morning Session was opened with the showing of two short films: *Living in Space*, a 13-minute color film by Aero-Space Division of Boeing Airplane Co.; and *Space Pioneer*, a 10-minute production by the U.S. Information Agency.

An especially impressive and delightful film—*Donald in Mathmagicland*—preceded the Monday afternoon Session. Produced by Walt Disney, this 27-minute film has gained wide acclaim as "poetic," "original," and as "visual excitement." The Tuesday morning session was preceded by a 10-minute film produced by Convair Astronautics, *High-Speed Cineradiography*.

A timely and extremely impressive color film, *Count Down at White Sands*, was shown preceding the Tuesday afternoon Session. This film was produced by the U.S. Army Signal Missile Support Agency, White Sands Missile Range, N.M. Two extraordinary films, both with philosophical overtones, were shown on Wednesday: *T Plus Infinity*, produced by the Missiles and Space Division of Lockheed Aircraft Corp., was shown Wednesday morning; and *Day Before Tomorrow*, a 24-minute color film was shown Wednesday afternoon. This film was produced by the Ballistic Research Laboratories, Aberdeen, Md. Another film produced at the White Sands Missile Range was shown Thursday morning—a highly technical and informative film, *Photo-Optics at White Sands*, is a 12-minute color film. Shown before the Thursday afternoon Session was *Schlieren*, a 19-minute film in color, a production of the Shell Oil Co.

Another film on science, shown before the Friday morning Session, was *Solids in the World Around Us*, a 14-minute color film produced by the Central Scientific Company of Chicago.

Another strange, not exactly "off-beat," but highly original film was *The Revealing Eye*, shown preceding the Friday afternoon Session. This is a 19-minute color film produced by the Shell Oil Co.

The wonderful Walt Disney film, *Mysteries of the Deep*, was shown before the Friday evening Session. This 24-minute film is in Technicolor. The Saturday morning Session was preceded by an informative and technically excellent film, *Principles of Digital Communications*, a 16-minute production by Calvin Productions, Inc.

The film scheduled before the final (Saturday afternoon) session was *The High-Speed Photography of Liquid/Solid Impact* produced by Laboratory for the Physics and Chemistry of Solids, Cavendish Laboratory, University of Cambridge, England.

A special showing of *Harvest Time in the Pacific Northwest* was arranged on Saturday afternoon. This was an example of cinematography to show modern farm combines working on the steep slopes of the rich wheat-lands of Washington, Oregon and Idaho. It is an 18-minute film in color produced by Reid H. Ray Film Industries.

Ceremonies and Entertainment

On Sunday afternoon two films were shown, a full-length feature, *I Aim at the Stars*, and a half-hour film, *Man in Space*. The feature film, produced by Columbia, is based on the life of Wernher von Braun, world-famous rocket scientist. It was filmed in Munich and had its world premiere there. The short film was produced by Walt Disney. It combines live action and animation to dramatize suggested methods of getting Man into Space, including demonstration in detail of the launching of an Earth satellite.

The official opening of the Congress took place Monday evening with addresses of welcome followed by a reception. Guest Speaker was Crawford H. Greenewalt, President, E. I. du Pont de Nemours & Co. who, in his spare time from running the du Pont Company, has gained wide fame for his photographs of humming birds and insects in flight. He is the author of a book, recently published by Doubleday & Co. Entitled *Hummingbirds*, it is lavishly illustrated with many astonishingly beautiful photographs. He is also a contributor to *National Geographic Magazine*. A friendly, informal talk by Mr. Greenewalt was illustrated by a film. A paper by W. O. S. Johnson in the July 1960 issue of the *Journal* (pp. 485–488) acknowledges the "generous assistance" of Mr. Greenewalt, for whom one of the two cameras described in the paper was originally produced. The camera built for Mr. Greenewalt, a 16mm high-speed camera, was first built for use in studying the flight of birds.

The Fifth Congress "party circuit" was unusually noteworthy, not only in terms of the variety of entertainment offered the Delegates and other distinguished persons attending the Fifth Congress, but also for the formal occasions and the "fun-type" events. The first important social event was the reception which took place Monday evening in the Florentine Foyer, after Mr. Greenewalt's talk.

The following evening (Tuesday) was given over to the Awards Session, reported in later pages of this issue of the *Journal*. A special part of that evening was an entertaining and enlightening presentation of "Muscles to Missiles" by J. Lewis Powell of the office of the Assistant Secretary of Defense. Wednesday evening was fun night: a charmingly informal evening planned for relaxation and amusement was highlighted by a floor show given by top entertainers supported by an 11-piece orchestra under the direction of Jack Minovich.

The Fifth International Congress dinner was the main event for Thursday night, preceded by a cocktail party. The same careful planning that made previous social events so outstandingly successful resulted in a dinner of consequence. Following the dinner the guests were entertained by the U.S. Army Chorus of

35 male voices, under the direction of Captain Samuel Laboda.

A Farewell Party was given Friday evening. This was an informal gathering at which old friends met to strengthen the ties of friendship and new friends made plans for the future.

Interspersed with the main social events were tours and special occasions planned for the ladies. One of the most successful of these occasions was a three-hour Embassy Tour, during which the group was received at the Embassy of Israel and the Embassy of Japan. Embassy staff members welcomed the ladies and conducted them on a tour of the buildings. Many of the tour members commented on the atmosphere of graciousness and hospitality at both Embassies. The schedule allowed time for sightseeing by individuals or small groups on a basis of personal preference. With so much to see and so many spots of historic interest to visit in Washington, many of the ladies described themselves as "thrilled" with the visit.

At dinner with the guest speaker before the Congress Opening. Front row, left to right: Harold E. Edgerton, Massachusetts Institute of Technology; Wilton R. Holm, Secretary; Crawford H. Greenewalt, President, E. I. du Pont de Nemours & Co.; Norwood L. Simmons, President; Dr.-Ing. Hubert Schardin, German-French Research Institute. Back row: Reid H. Ray, Convention Vice-President; Ethan M. Stifle, Financial Vice-President; G. Carleton Hunt, Treasurer; Glenn E. Matthews, Editorial Vice-President; Paul E. Klopsteg, Chairman of the Board of Directors, American Association for the Advancement of Science; John W. Servies, Executive Vice-President; Deane R. White, Engineering Vice-President; Garland C. Misener, Sections Vice-President.

Registration

Registration began early with a very heavy pre-registration and also a large registration beginning at 2.00 P.M. on Sunday. Including those attending the Equipment Exhibit, described below, over 2000 registered at the Congress. Besides the National Delegates, substantial numbers of visitors traveled to the Congress from 18 foreign countries, the largest contingents coming from England (32), France (22) and Germany (19).

Congress registrants received a plastic briefcase which contained working materials, the Final Program and information about Washington. Special enclosures were a *Bibliography on High-Speed Photography*, compiled by Elsie L. Garvin and distributed by courtesy of the Eastman Kodak Co.; and the SMPTE Reprint Volume 1, Series II, of "Instrumentation and High-Speed Photography," a 187-page book.

Distinguished Foreign Visitors

Lending excitement to the total picture of the Fifth Congress were numbers of distinguished foreign visitors, many of them internationally known for their scientific achievements.

One of the most interesting of these visitors was Mlle. Marie Merle of the Centre de Recherches Scientifiques, Industrielles et Maritimes de Marseille, France. Although many women have made many significant contributions in many branches of science, a scientist of the importance of Mlle. Merle in this particular field is still sufficiently unusual to be worthy of note. Mlle. Merle is co-author with F. Canac of a paper on "A Study of the Structure and the Ultrasonic Emission of a High-Speed Air Jet With an Ultra-High-Speed Electronic Camera," which was presented during the Session on Applications — Flow Dynamics, held Saturday.

Mention of a few other distinguished foreign visitors is made on a "spot check" basis to set forth examples that may be representative of the type of achievement and recognition accorded the many scientists at the Fifth Congress from countries other than the United States.

One visitor, who might be described as a "veteran" of High-Speed Congresses, was W. D. Chesterman of the Royal Naval Scientific Service, who served as an active and extremely successful organizer of the Third High Speed Congress held in London. He is best known as an authority on flash tubes and underwater applications of high-speed photography and has conducted extensive research in this field. He is Chairman of the United Kingdom Committee on High-Speed Photography and is the author of a well-known treatise, *Photographic Studies of Rapid Events.*

Another distinguished visitor from Great

The high table at the Banquet in Honor of Foreign Delegates. Left to right: Glenn E. Matthews, Editorial Vice-President; Mrs. Matthews; Dr.-Ing. Hubert Schardin; Mrs. Beard; D. Max Beard, 5th Congress Chairman; Mrs. Simmons; Byron Roudabush, Local Arrangements Chairman; Norwood L. Simmons, President; Mrs. Servies; John W. Servies, Executive Vice-President; Mrs. Ray; Reid H. Ray, Convention Vice-President; Mrs. Roudabush.

One of the government displays adjoining the Equipment Exhibit. Below: two of the six aisles of commercial exhibits.

Britain was John Hadland of John Hadland & Co., whose interest in high-speed photography and recognition of its importance to the progress of science has led him to take an active interest in research and promotion activities.

Government activities in Great Britain in the high-speed field were represented by a distinguished group. E. W. Walker, who is world-renowned for his work in high-voltage x-ray equipment and high-speed Kerr cells, is presently conducting research at the Atomic Weapons Research Establishment at Aldermaston, Berks, where ultra-high-speed rotating mirror cameras have been installed.

A well-known name in high-speed circles is that of Dr.-Ing. Frank Früngel, who has influenced the advancement of high-speed photography both as a science and as a business, especially in the field of stroboscopic light scources.

A distinguished visitor from France was Paul Devaux of the Laboratoire Central de l'Armament, Arcueil, France. One of the long-time great names in the high-speed field, M. Devaux told the Second High-Speed Congress, held in Paris in 1954, of research, then in the initial stage, in techniques, equipments and possible applications of high-speed photography. Continuing research engaged in by M. Devaux has resulted in the finding of solutions of many of the early problems uncovered by the previous stage of the research project.

R. J. North of the National Physical Laboratory at Teddington, Middlesex, England, (whose Fifth Congress paper on "High-Speed Photography Applied to High-Speed Aerodynamic Research at the National Physical Laboratory," appears in the October 1960 *Journal* on pp. 711–719) is well known in high-speed and government circles for his achievements in the use of schlieren and interferometric techniques in connection with aerodynamics and wind tunnel studies.

Another visitor, Karl Vollrath of the Institut Franco-Allemand de Recherches, St.-Louis, France, has long been recognized as an able scientist specializing in this particular field.

A noted (and charming) visitor from Japan was Kiyohiko Shimasaki, Editor of *Motion Picture Engineering* (the journal of the Motion Picture Engineers Society of Japan). Representing the Japanese Society at the Convention, his three-fold activities of listening, learning and reporting were ably carried out.

Among the many "visiting neighbors" from Canada was Spencer W. Caldwell of S. W. Caldwell Co.

Besides Dr. A. I. Tchernyi, who is with the Research Laboratory of the State Optical Works, Leningrad, and was National Delegate for the Fifth Congress, the USSR sent a distinguished delegation under Nikolai Zandin as Delegation Chairman. Mr. Zandin came from the State Scientific Technical Committee, Moscow, as did Victor Baikov, Georgi Chnirman, M. Kudriashov, Juri Nesterikhin, Vladimir Tchnikrysov, Georgi Voitsekhorski and Krmian Vorazdat. Migkhat Kazimov came from the Kasahis Scientific Academy, Alma-ata, USSR.

Equipment Exhibit

The special nature of the Congress, in contrast to a regular SMPTE convention, showed up prominently in the size and in the make-up of the Exhibit. The sixty booths available in the area were all filled, and a few additional ones had to be put in at the last minute for late-comers.

The equipment shown was probably the largest collection of laboratory, studio and field devices for photographic instrumentation ever assembled in one place. Products of major U.S. manufacturers in this specialized field, alongside many from Britain, Germany, Canada and Japan, ranged all the way from small precision components to great multi-ton interferometers. The companies represented were:

Animation Equipment Corp.
Ansco Div., General Aniline & Film Corp.
Arriflex Corp. of America
Avco Corp., Research & Advanced Dev. Div.
Barr & Stroud Ltd.
Beckman & Whitley, Inc.
Bell & Howell Co.
Benson-Lehner Corp.
Camera Equipment Co.
Canadian Applied Research Ltd.
Computer Measurements Co.
Consolidated Systems Corp.
E. I. du Pont de Nemours & Co.
Eastman Kodak Co.
Edgerton, Germeshausen & Grier, Inc.

Exhibit

89th SMPTE Semiannual Convention

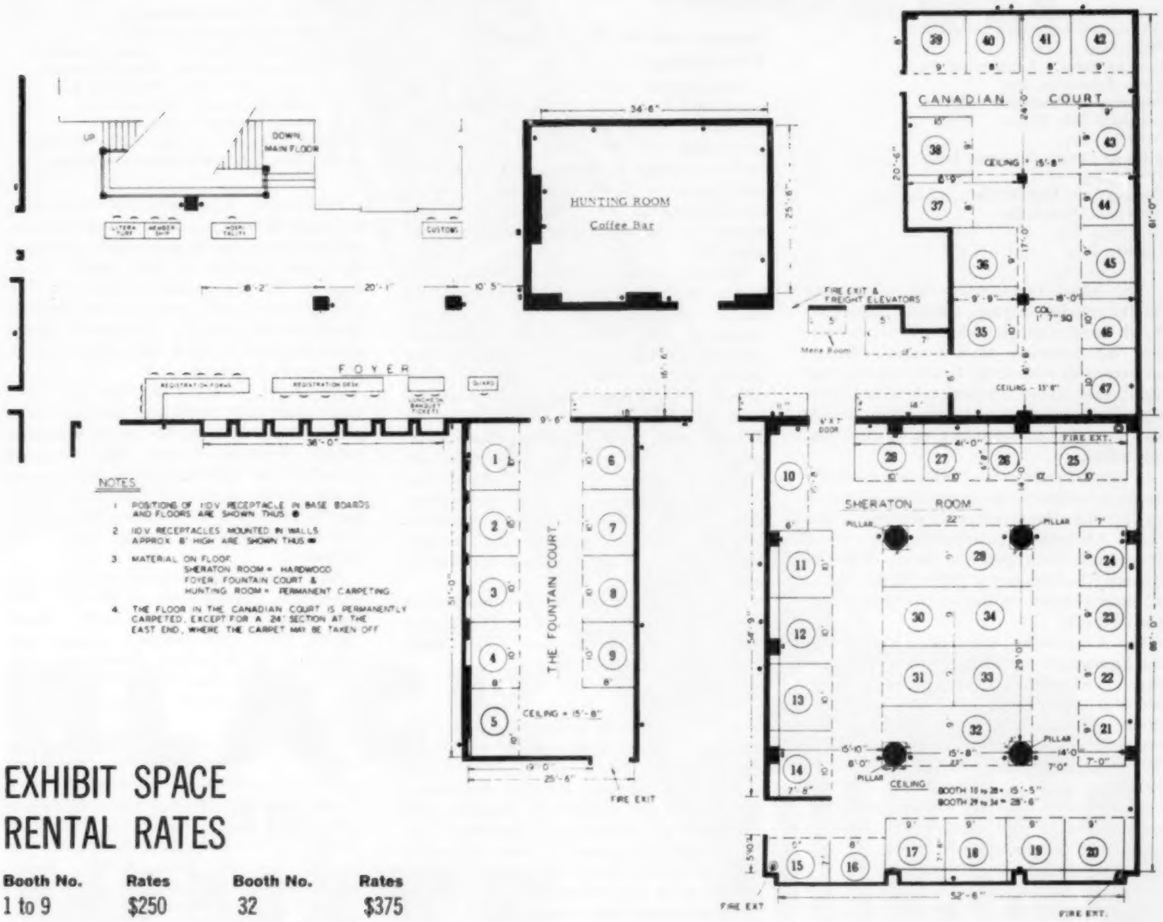


EXHIBIT SPACE RENTAL RATES

Booth No.	Rates	Booth No.	Rates
1 to 9	$250	32	$375
10	200	33 & 34	270
11 to 14	250	35	260
*15 & 16	150	36	250
17 to 24	250	37 to 42	240
25 to 28	260	43 to 45	250
29	385	46 & 47	260
30 & 31	270		

*Booths 15 & 16 are very small; therefore, both spaces will be rented as one unit for a total of $260.00.

FOR RESERVATIONS:

contact the Exhibit Chairman:

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Fairchild Camera & Instrument Corp.
Field Emission Corp.
Filmline Corp.
Oscar Fisher Co.
Flight Research, Inc.
Florman & Babb, Inc.
Dr.-Ing. Frank Früngel GmbH
Heico, Inc.
Karl Heitz, Inc.
Hi-Speed Equipment, Inc.
Hollywood Film Co.
Philip A. Hunt Co.
Kelvin-Hughes Ltd.
Kenyon Products, Inc.
L. W. Photo Products Co.
D. B. Milliken Co.
Minnesota Mining & Mfg. Co.
Motion Picture Enterprises, Inc.
Neumade Products Corp.
Nissei Sangyo Co., Ltd.
O'Connor Engineering Laboratories
Photo-Sonics, Inc.
Peterson Sales & Engineering, Inc.
Photo Animation, Inc.
Precision Laboratories Div.
Prestoseal Mfg. Corp.
Polaroid Corp.
Sylvania Electric Products, Inc.
Traid Corp.
Westinghouse Electric Corp., Lamp Div.
Wollensak Optical Co.
Carl Zeiss, Inc.
Zoomar, Inc.

The man responsible for organizing this impressive display, Exhibit Chairman Keith Lewis, capped the months of preparation by ensuring smooth and efficient operation all week long. Keith and his good right hand, Rosemary Butler, between them expertly juggled the innumerable details necessary for the comfort of visitors and exhibitors.

A special section had been set aside for displays by government agencies, arranged for by the Department of Defense. The Naval Ordnance Laboratory, the Naval Propellant Plant and the Army Ballistics Research Laboratory at White Sands, N.M., all had extensive exhibits of equipment and photographs.

On Wednesday morning, October 19, the Equipment Papers and Demonstrations Session, where exhibitors had an opportunity of presenting some of their new products, drew an unusually large audience. The session was very ably conducted by Harry Teitelbaum of Hollywood Film Co., an exhibitor himself as well as SMPTE Convention Vice-President Elect. Representatives of the following companies made brief presentations:

Carl Zeiss, Inc.: Zeiss Interferometer

Beckman & Whitley, Inc.: Model 339 Continuous Writing Streak Camera

Benson-Lehner, Inc.: Puppet Timing System; Ultra-High-Speed Framing Camera

Traid Corp.: Traid 180° Lens for 35mm Cameras and Photo-Sonics 16mm High-Speed Prism Camera

Eastman Kodak Co.: New Color Films for High-Speed Motion-Picture Photography

Wollensak Optical Co.: Lightweight Reversal-Negative 16mm Film Processor; Fastax-Fastair High-Speed Camera Improvements

Polaroid Corp.: Polaroid-Land Film Products with 10-sec Development

Ansco Div.: Ansco Automatic Recording Microdensitometer

Florman & Babb, Inc.: Acmade Mark II Editor

Karl Heitz, Inc.: Kinoptik Lenses

L. W. Photo Products, Inc.: L-W Industrialist 16mm Stop-Motion Instrumentation Projector

Nissei Sanygo Co., Ltd.: Hitachi High-Speed Motion-Picture Camera

Prestoseal Mfg. Corp.: 16-35-70mm Butt-Weld Splicer for Intermixed Material

Activity and interest were high in the Exhibit area each day of the Congress and many individuals who were not attending the Congress came from considerable distances to see the equipment. By the end of the week the number of visitors had reached 1000, in addition to registrants at the Congress. For those who may be interested, a list of these Exhibit visitors can be obtained on request from SMPTE headquarters.

Symposium on High-Speed Processing

Immediately preceding the Fifth Congress, on October 14–15, a two-day Symposium covering all phases of high-speed processing was conducted by the Society of Photographic Scientists and Engineers at the Shoreham Hotel. The importance of, and interest in this specialized field was shown by the large registration — more than 500.

Specific areas of the broad, general topics of fundamental studies, fast and simple methods, new fast processing materials and advances in equipment design were explored in 26 papers presented during four Sessions. The Friday Morning Session was opened by an invited paper by George T. Eaton on "The Revolution in Photographic Processing." Another invited paper, by Edward K. Kaprelian on "Future Military and Commercial Applications of Short Access Time Photography," was presented at the Saturday Morning Sessions. Other papers discussed new equipments and processes specifically and in detail.

The papers are planned for publication by the SPSE in its journal, *Photographic Science and Engineering*, Box 1609, Main Post Office, Washington, D.C.

Proceedings

All of the papers presented at the Fifth Congress will be reviewed by the Board serving under Dr. J. S. Courtney-Pratt, Editorial Chairman for the *Proceedings*. Papers will be printed in English with abstracts in French and German. The Discussions (questions and answers) which followed presentations of the papers will be published in the *Proceedings*. The copy for the Discussions was gathered and supervised during the Congress by Miss Lisel Löper from the Institut Franco-Allemand de Recherches, St.-Louis, France. The discussions were also recorded in three languages on tape as an additional guide for preparing the *Proceedings* copy.

A considerable number of the papers will appear in the *SMPTE Journal* before publication of the *Proceedings*. These are chosen from the Sessions on other than special applications.

The Editorial Board for the *Proceedings* is:

Max Beard, U. S. Naval Ordnance Laboratory
R. M. Betty, Lockheed Missiles
Berlyn Brixner, Los Alamos Scientific Laboratory, Univ. of California
W. E. Buck, Boulder, Colo.
H. E. Edgerton, Massachusetts Institute of Technology
Carlos Elmer, Traid Corp.
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A. M. Ericson, U. S. Naval Ordnance Laboratory
David C. Gilkeson, Wollensak Optical Co.
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Guy Hearon, Benson-Lehner Corp.
John H. Hett, Hett Associates
Thomas E. Holland, Beckman & Whitley, Inc.
W. G. Hyzer, Janesville, Wis.
Sigmund J. Jacobs, U. S. Naval Ordnance Laboratory
W. O. S. Johnson, E. I. du Pont de Nemours & Co.
Karl Leistner, U.S. Army Signal Research and Development Laboratory
Glenn E. Matthews, Eastman Kodak Co.
Albert May, U.S. Naval Ordnance Laboratory
Richard O. Painter, General Motors Proving Ground
F. H. Perrin, Eastman Kodak Co.
A. C. Robertson, Eastman Kodak Co.
Th. W. Schmidt, Office of Ordnance Research
Morton Sultanoff, Aberdeen Proving Ground
Vernon Taylor, U.S. Public Health Services
L. R. Teepie, Beckman & Whitley, Inc.
H. I. Trenary, General Electric Co.
Willett R. Wilson, Westinghouse Electric Corp.
A. M. Zarem, Electro-Optical Systems, Inc.

Publication is expected by mid-1961; the exact date of publication and the price of the volume will be announced as soon as the final schedule is laid down. Many requests for information about the *Proceedings* have been received at SMPTE Headquarters and a Tentative Order Form is available upon request to facilitate indications of interest.

A number of inquiries have also been made about the published proceedings of previous Congresses. In some instances, papers presented at the Fifth Congress described the continuation of experiments or the results of research first described in papers presented at previous Congresses. These Congress Proceedings have been published:

First International Congress on High-Speed Photography (Symposium at the 72d SMPTE Convention, October 1952, Washington, D.C.): All available papers were published in *High-Speed Photography, Volume 5*, SMPTE, New York, 1954. 359 pp. 6 × 9 in. Price \$4.50. Papers are printed in English.

Second Congress (2ème Congrès International de Photographie et Cinématographie Ultra-Rapides), September 1954, Paris: *Proceedings (Photographie et Cinématographie Ultra-Rapides)* published (1956) by Dunod, 92 rue Bonaparte, Paris 6. 455 pp. $8\frac{1}{4}$ × $11\frac{1}{4}$ in. Price \$17.25. Papers are printed in the language in which they were given, with summaries in English, French and German.

Third Congress on High-Speed Photography, September 1956, London: *Proceedings* published (1957) by Butterworths Publications Ltd., 88 Kingsway, London WC2; in U.S. by Academic Press Inc., 111 Fifth Ave., New York 3. 417 pp. $9\frac{3}{4}$ × 6 in. Price \$13.00. Papers are printed in English.

Fourth Congress (IV. Internationaler Kongress über Kurzzeitphotographie und Hochfrequenzkinematographie), September 1958, Cologne: *Proceedings (Kurzzeitphotographie)* published (1959) by Verlag Dr. Othmar Helwich, Darmstadt, Hoffmannstr. 59. 340 pp. 7 × 10 in. Price \$22.00. Papers are printed in the language in which they were given, with summaries in English, French and German.

Society Awards

J. Lewis Powell, Special Assistant on the staff of the Assistant Secretary of Defense, guest speaker at the Awards Session.

New Fellows of the Society. Front row, left to right: Sigmund J. Jacobs, Hubert Schardin, Charles W. Wyckoff, John R. Turner, Richard E. Putman. Back row: Morton Sultanoff, Robert C. Rheineck, Neal G. Keehn, Fred J. Scobey, Eldon Moyer, Jerome C. Diebold.

A special session for the made in advance of awards was held the evening of October 18 in the Sheraton Hall with President Norwood L. Simmons presiding. Guest speaker was J. Lewis Powell, of the Office of the Assistant Secretary of Defense who spoke on "Muscles to Missiles." Session arrangements were under the direction of Joseph E. Aiken of the U.S. Naval Photographic Center.

Some of the special activities and accomplishments of the Society were reflected in awards and citations other than those given each year.

Special Citations

Citation to John Waddell

John Waddell was presented with a citation in recognition of his efforts in bringing about the first International Congress on High-Speed Photography which was held in Washington, D.C., under the sponsorship of the Society of Motion Picture and Television Engineers and concurrent with the 72d SMPTE Convention. As the Certificate stated, this was "in recognition of his outstanding service and able leadership in the organization of the first International Congress on High-Speed Photography in Washington, D.C., October 6–10, 1952, which served to initiate a continuing series of international symposia providing for the free interchange of scientific and technological thought in the field of high-speed photography."

Progress Reports

A Special Citation was made in advance to Lloyd Thompson for "outstanding services as Chairman of the Society's Progress Committee in the preparation of five excellent reports on world progress in motion-picture and television engineering and instrumentation and high-speed photography." Mr. Thompson retired this year as Chairman of the Progress Committee after five years of service.

Control Techniques in Film Processing

In recognition of the monumental task performed by Walter I. Kisner, Chairman, and the Subcommittee of the SMPTE Laboratory Practice Committee which prepared *Control Techniques in Film Processing*, citations were given earlier to members of the Subcommittee and Chairman Kisner who also was coordinator and editor of the book.

Scrolls to National Delegates

As a special gesture of appreciation a certificate was presented to each of the National Delegates, "in recognition of services to the Fifth International Congress."

E. I. du Pont Gold Medal

First recipient of the newly established E. I. du Pont Gold Medal Award is Prof. Dr.-Ing. Hubert H. Schardin, Director of the German-French Research Institute, St.-Louis, France. The award was made in recognition of his outstanding career and pioneering work in the field of high-speed photography.

This award will be offered annually to an individual selected by the SMPTE for outstanding contributions to the development of techniques and equipment in the fields of instrumentation and high-speed pho-

Dr.-Ing. Hubert Schardin receives the E. I. du Pont Gold Medal Award from President Norwood L. Simmons. Garland C. Misener, Chairman of the Award Committee, is at the left.

Ub Iwerks, Walt Disney Productions, holds the Herbert T. Kalmus Gold Medal Award presented to him by President Norwood L. Simmons, while William E. Gephart, Jr., Chairman of the Award Committee, looks on.

tography. The E. I. du Pont Gold Medal Award is sponsored by the Photo Products Department of E. I. du Pont de Nemours and Company. The firm has been a major supplier of film to the motion-picture industry since 1925 and has made a number of significant contributions to the development of motion-picture film through its broad research program.

The citation was read by Garland C. Misener, Chairman of the Ad Hoc Committee on Special Awards:

Over the past twenty-five years, Professor Schardin has carved a singularly outstanding career in the field of high-speed photographic instrumentation, and in ballistic studies applying this instrumentation. In recognition of his originality, ingenious inventiveness and exceptional ability, many of the techniques and physical events observed by these techniques bear his name. Time does not permit a listing of his papers, many of which are classics in the instrumentation and physical research fields. It seems more appropriate, on this occasion of the first presentation of the E. I. du Pont Gold Medal Award, to acquaint you with the man, since everyone in photographic instrumentation, or its scientific applications, is acquainted with Professor Schardin's technical accomplishments and publications.

In 1927 he entered the Geheimrat Military Institute of Professor Carl Cranz, the founder of modern ballistics, where he obtained his doctorate in physics in 1934. His thesis, which followed many earlier publications on high-speed photographic techniques dating back to 1929, was the result of an outstanding research project covering high-speed photographic instrumentation for ballistic events, and was entitled "The Quantitative Application of the Schlieren Method." Professor Schardin was soon appointed as assistant to Professor Cranz. In 1935 they were commissioned by the Chinese to establish the first military institute in China.

After a year in China, Professor Schardin was appointed to the position of Director of the Ballistic Research Institute of the Technical Air Force Academy in Berlin. The Academy soon built the reputation of being the most outstanding ballistic and high-speed photographic institute in the world. New techniques which led to the de-

Otto H. Schade, Radio Corp. of America, center, is presented with the Progress Medal Award by President Norwood L. Simmons. Deane R. White, Award Committee Chairman, is at the left.

Dr. William F. Schreiber, Massachusetts Institute of Technology, recipient of the Journal Award, talks with President Norwood L. Simmons and James L. Wassell, Chairman of the Award Committee.

Student Award winners with President Norwood L. Simmons and James L. Wassell, Chairman of the Award Committee. Left to right: Richard Burkhart, Mr. Wassell, Conrad Strub and Dr. Simmons.

velopment of the well-known Askania bombsight, to analysis of armor penetration by solid shot and shaped charge, and many more developed under the capable direction of Professor Schardin.

At the end of World War II, most of the staff of the Academy moved to the Lake Constance area where remnants of the Air Force Technical Academy were housed. Soon, General Fayolle and a group of top French scientists visited Professor Schardin, and were impressed by his modern ballistics concepts. Later, in June 1959, President DeGaulle and the French Congress approved the establishment of the Joint French-German Institute St.-Louis, with Professor Schardin as Scientific Director, the position which he now holds.

Professor Schardin is not content merely with his important official responsibilities. He is also an active lecturer as Director of Technical Physics at the University of Freiburg.

He has also established, and is active in, an Adult Education School in his home town of Weil am Rhein, which stresses both technical and non-technical education. As an extension of work with the Fraunhofer Society, the Ernst Mach Institute has been set up under Dr. Schardin's directorship. Here he is free to extend nonmilitary studies in his favorite research projects on brittle fracture processes and related high-speed events.

At home, his wife and four daughters and his friends enjoy color slide shows of Professor Schardin's excellent collection of flower pictures.

Those who have been fortunate enough to have personal contact with Professor Schardin, recognize in this quiet, unpretentious man, an outstanding ability to grasp any situation with penetrating insight, and a determination and drive which will not be deterred however great the difficulties.

The presentation of the SMPTE E. I. du Pont Gold Medal Award to Professor Schardin is not only recognition of his stellar career, but it is also recognition of his current achievements, which have grown in significance with each new development, adding greatly to the universal knowledge of ballistic phenomena through high-speed photographic instrumentation.

In accepting the award, Prof. Schardin said:

It is a very great honor for me to receive today the E. I. du Pont Gold Medal Award of the Society for 1960.

For more than 30 years I have been working in the field of high-speed photography. I consider this Gold Medal not only as a recognition of my own work but also as a visible sign that high-speed photography has become an important tool of research in opening the world of high-speed phenomena. In 1864, the first professor holding a chair for photography at the Technical University in Berlin, Vernanne Vogel, said in a talk he gave in memory of Louis Jacques Daguerre, the first famous person in France who had taken permanent photographic pictures: "What the invention of printing did for the preservation of thoughts and ideas the invention of photography does and will do for the recording of the visible world."

We cannot conceive of the modern world without photography, not only to take portraits, or to produce souvenirs, but also for scientific purposes: to record an exact image of a physical phenomenon at a definite time. However old-fashioned photography does not give us what we believe is essential for recording motion.

At the end of the last century and thanks to the work of Anschutz, Edison, Lumiere, Messter, and others, cinematography was born.

The continuous sequence of frames enables us to record our surroundings in a dynamic fashion — in a similar manner as we see it with our eyes — and to reproduce this moving picture as often as we want to. But whereas normal cinematography reproduces only what we can see with our eyes, high-speed cinematography or high-speed photography opens up a new world — the world of rapid events, which we may call high-speed physics or short-time physics.

For the first cas·, the frames of a high-speed cinematographic series are used for a physical evaluation but — if the frames are projected — the high-speed phenom-

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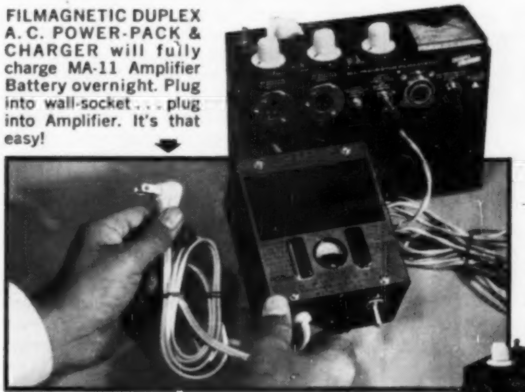

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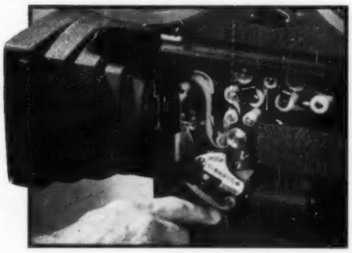

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enon can be followed with the eyes. The enlargement of the time goes up to a million times as the electronic space microscope.

This possibility of the projection of a high-speed phenomenon must be sufficiently appreciated; because by reviewing such a high-speed film one obtains a direct feeling for events which do not necessarily agree with our normal experience. For instance, the inertia of mass plays a much more important role in high-speed events. And I believe to be justified to claim that even a good physicist is more frequently guided in judging a physical event by his feelings than he himself believes.

I became an enthusiast of high-speed-photography, thanks to the inspiration from my teacher, Carl Cranz, 35 years ago. He was a ballistic expert and found out that high-speed photography is a very important tool to establish a physical understanding of ballistic events.

If I succeeded in contributing a little bit to the development of high-speed photography itself, and in applying high-speed photography for several research problems, I emphasize that this was only possible (1) by the foundations I owe to my teacher, Carl Cranz; and (2) by luck, that for 25 years I was surrounded by a number of very able co-workers, some of whom are present here today.

At this moment, I would like to add to the thanks which I owe to the Society of Motion Picture and Television Engineers which has honored me with the E. I. du Pont Gold Medal Award, and with thanks to my colleagues who work together with me in the field of high-speed photography in the laboratories in St.-Louis, France, and in Freiburg, Germany.

Honor Roll

The name of Oskar Messter was placed on the Honor Roll of the Society. Names on the Honor Roll, now numbering 23, are those of distinguished pioneers who were Honorary Members of the Society or whose work has been posthumously recognized as fully meriting this award.

The citation was prepared by the Honorary Membership Committee under the Chairmanship of Charles R. Fordyce:

In 1895 Oskar Messter of Berlin, Germany, began work on his noteworthy inventions of motion-picture equipment. His first projector was built and sold in 1896. Also in that year he started to make entertainment films and was author, director, processor, printer and projectionist of many of them.

Between 1896 and 1920 he brought out 17 new models of projectors, including several which used the principle of optical compensation. His first camera was built in 1896.

He owned and operated several large studios in Berlin and one in Vienna during his lifetime. In 1901 he founded the Kosmograph Company (later known as Messter Film GmbH) which specialized in the manufacture and professional demonstration of equipment as well as motion-picture production. In October 1914 he started the "Messter Week," a weekly newsreel which became famous through its truthful news reporting.

Starting about 1903 he began designing and building various electrical equipment for the synchronization of projected motion pictures with sound from phonograph records.

He gave performances in Europe and at the World's Fair in St. Louis in 1904. By 1913, over 500 theaters in Europe had installed his synchronizer called the Biophone.

In 1900 he began experimenting with color motion pictures and built a triple-lens camera for additive-color cinematography. This camera and other equipment built by Messter are on display in the German Museum in Munich.

For his distinguished contributions to many fields of cinematography, he was awarded on December 1, 1927, the first Oskar Messter Medal of the Deutsche Kinotechnische Gesellschaft. Messter was the first president of this important technil cal society in 1920. In 1936, the Technica-University of Berlin granted him the title of Honorary Senator in recognition of his services to university education. The German Museum in Munich appointed him a life member of its committee and bestowed on him the golden museum ring.

A review of his more than 60 German patents shows the tremendous versatility of this inventive mind. For nearly 50 years, this distinguished German pioneer dedicated his life to the development and improvement of the science and the art of motion pictures. He has earned for himself a well-deserved place among the outstanding pioneers in cinematography. The SMPTE takes pride in adding the name of Oskar Messter to its Honor Roll.

(See also "Oskar Messter and His Work" by Albert Narath in the October 1960 *Journal*, pp. 726–734.)

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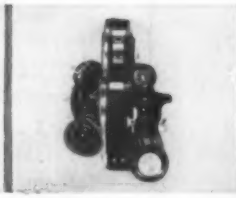
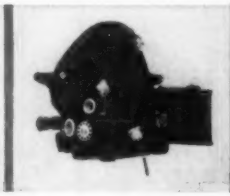


Rear view, showing Arriflex 16's distinctive components: eyepiece of direct-viewing finder; tachometer; footage and frame counters; variable speed control for the motor.

Unique turret design permits any 3 lenses, from extreme-wide-angle to 300 mm telephoto, to be mounted simultaneously without mechanical or optical interference with one another.



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*ANNUAL INDUSTRIAL FILM AWARDS - conducted by the publishers of Industrial Photography magazine.

FOR LITERATURE OR DEMONSTRATION OF ARRIFLEX 16MM AND ARRIFLEX 35MM CAMERAS. WRITE TO:

Fellows

The following members were raised to the rank of Fellow. Certificates were presented by Ethan M. Stifle, Financial Vice-President:

Edw. P. Ancona, Jr.	Richard E. Putnam
Jerome C. Diebold	Robert C. Rheineck
George C. Higgins	Hubert H. Schardin
Sigmund J. Jacobs	Fred J. Scobey
Neal G. Keehn	Morton Sultanoff
Eldon Moyer	John R. Turner
Richard S. O'Brien	Charles W. Wyckoff

Journal Award

The 1960 Journal Award was presented for the paper "Synthetic Highs—An Experimental TV Bandwidth Reduction System," to the authors, William F. Schreiber, Christopher F. Knapp and Norman D. Kay. The paper, published in the August 1959 *Journal*, describes an extensive research project carried on by the authors at Technicolor Corp.

For Honorable Mention, the Journal Award Committee chose a group of three papers entitled, "An Engineering Approach to Television Film," which appeared in the November 1959 issue of the *Journal*. The authors are L. J. Murch, Harold Wright and Rodger J. Ross, all with the Canadian Broadcasting Corp.

James L. Wassell, Chairman of the Committee, read the Journal Award citation.

Student Member Award

The Student Member Award was presented to Richard E. Burkhart and Conrad A. Strub of Rochester Institute of Technology for their paper "Development Determination by Infrared Sensitometry."

The Student Member Award was created to afford special recognition to those Society Members who are today preparing themselves for positions in the motion-picture and television field.

Progress Medal

1960 Progress Medal of the Society was presented to Otto H. Schade, Sr., staff engineer at Radio Corporation of America in Harrison, N. J., for outstanding technical contributions to the progress of engineering phases of the motion picture and television industries. The citation, prepared by the Progress Medal Award Committee, was read by Deane R. White, Chairman:

Dr. Schade was born in Germany and studied at the Technische Hochschule, Berlin-Charlottenburg, from 1922–1924. In 1933 he received an honorary degree of Doctor of Electrical Engineering from Rensselaer Polytechnic Institute.

In 1926 he came to the United States and was employed by A. Atwater-Kent, Inc., as an engineer specializing in audio systems. He joined the Electron Tube Division of RCA in 1931 and since that time has been engaged in broad studies of electron tubes and their influence on the performance of audio and video systems. In the course of this work he found it necessary to originate methods and techniques for evaluating and specifying the several elements of a television or motion-picture system which determine its overall performance. His development of the sine wave response technique is recognized as a valuable contribution to the analysis of such systems. His numerous investigations in the motion-picture and television fields have resulted in many significant contributions to the technical literature, one of the most recent, "The Quality of Color Television Images and Perception of Color Detail," receiving Honorable Mention in the 1958 Journal Award.

For his outstanding accomplishments in the fields of television and motion-picture science and engineering Dr. Schade has been granted 75 U.S. patents. In 1941, the National Association of Manufacturers bestowed upon him its Modern Pioneer Award. He received the Morris Liebman Memorial Prize of the Institute of Radio Engineers in 1950. SMPTE honored him with its David Sarnoff Gold Medal in 1951 for his outstanding accomplishments in outlining the potentialities of television and film systems as to the fidelity of photography and reproduction of images. He is a Fellow of the IRE and of this Society.

Dr. Schade is presently engaged in research on the extension of electron tube theory and the electrical and thermal design of nuvistor tubes.

Herbert T. Kalmus Gold Medal

Ub Iwerks, Director of Technical Research at the Walt Disney Studio in Burbank, California, was awarded the 1960 Herbert T. Kalmus Gold Medal Award for his outstanding contributions to the tech-

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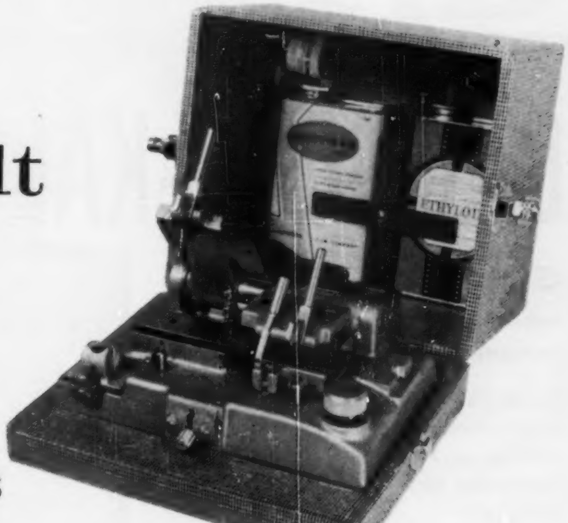

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nology in equipment and processes for the making of color motion pictures.

W. E. Gephart, Chairman of the Kalmus Award Committee, read the citation, prepared by the Committee, which states in part:

Mr. Iwerks directed and supervised the technical aspects in the making of color military training films during the war years. He developed the double-headed optical color printer for combining live action and cartoons which was used on such pictures as *Song of the South* and *Saludos Amigos* and developed the color correction masking process and color separation method used in 16mm color blow-ups to 35mm used in Disney's *True Life Adventure* series. He was largely responsible for developing the successive exposure method used to photograph color cartoons and has worked with the color paint laboratory at the Disney Studio in developing the cell color paints that give good photographic results for cartoons. He developed, in cooperation with Technicolor, the special anamorphic lens and photographic system used to make the 8-perforation color negatives used on *Sleeping Beauty*.

He helped in the development of the multiple-camera system used in *Circarama, U.S.A.*, which was shown in color at the Brussels World's Fair and last year in Moscow, and has recently been involved in the design of the xenon-lamp projection system for the American Telephone and Telegraph Circarama color exhibit at Disneyland. He recently developed the xerography process of transferring color animated drawings to cells now being used entirely in the new Walt Disney feature cartoon production, *101 Dalmations*.

Mr. Iwerks was first associated with Walt Disney in 1920 during the pioneering days of cartoon films. After operating his own studio for sixteen years, he rejoined Disney and became head of the special photographic effects department there. During his long association with Disney he has worked particularly on color photographic problems at the studio and at Disneyland.

Mr. Iwerks is a Fellow of the SMPTE and serves on the Board of Governors of the Society. He is also a member of the Academy of Motion Picture Arts and Sciences and the American Society of Cinematographers. In 1959 he was honored by the Academy of Motion Picture Arts and Sciences with a Technical Award for the design of an improved optical printer for special effects and matte shots in color.

The Herbert T. Kalmus Gold Medal Award established in 1955 is awarded each year to the individual who has made an outstanding contribution to the development of color films, processes, techniques or equipment useful for color motion pictures for theatrical, television, or other commercial uses.

SMPTE Elections

Results of the 1960 elections were announced at the 5th International High-Speed Congress. Officers elected (or reelected) for the 1961-62 term are:

President: John W. Servies
Executive Vice-President: Reid H. Ray
Editorial Vice-President: Lloyd Thompson
Convention Vice-President: Harry Teitelbaum
Secretary: Herbert E. Farmer
Six Governors were elected:
(East Coast) Walter I. Kisner and Rodger J. Ross
(Midwest Division) James W. Bostwick and Kenneth M. Mason
(West Coast) G. R. Crane and Robert G. Hufford

Section Officers and Managers elected are:

ATLANTA: Chairman, Wesley R. Sandell; *Secretary-Treasurer*, John C. Horne; *Board of Managers*, Edward E. Burris, Robert A. Holbrook and Leigh H. Kelley.

BOSTON: Chairman, Robert M. Fraser; *Secretary-Treasurer*, Lester Bernd; *Board of Managers*, Harris Cohen, Willard H. Hauser and Charles W. Wyckoff.

CANADA: Chairman, Findlay J. Quinn; *Secretary-Treasurer*, Harold Green; *Board of Managers*, Michael W. Barlow, Hellmut Berger and Maurice French.

CHICAGO: Chairman, William H. Smith; *Secretary-Treasurer*, Philip E. Smith; *Board of Managers*, Jack Behrend, Harold Kinzle and Hartwell T. Sweeney.

DALLAS–FORT WORTH: Chairman, Malcolm D. McCarty; *Secretary-Treasurer*, Richard T. Blair; *Board of Managers*, Lewis E. Cearly, Jr., Bruce S. Jamieson and Erwin J. Pattist.

HOLLYWOOD: Chairman, Ralph E. Lovell; *Secretary-Treasurer,* John P. Kiel; *Board of Managers,* Walter Beyer, Edward H. Reichard and Fred J. Scobey.

NASHVILLE: Chairman, Frank M. McGeary; *Secretary-Treasurer,* Herschell R. Briscoe, Jr.; *Board of Managers,* Wilford W. Gebhart, Ralph H. Hucaby and Anton Pilversack.

NEW YORK: Chairman, James W. Kaylor; *Secretary-Treasurer,* William H. Metzger; *Board of Managers,* John V. Leahy, George Lewin and Edward Schmidt.

ROCHESTER: Chairman, Eric C. Johnson; *Secretary-Treasurer,* D. Lisle Conway; *Board of Managers,* Bruce R. Beiswenger, Wayne E. Humm and Forrest A. Richey.

SAN FRANCISCO: Chairman, Donald E. Anderson; *Secretary-Treasurer,* Clifton R. Skinner; *Board of Managers,* W. A. High, Stewart A. Macondray and W. A. Palmer.

WASHINGTON, D.C.: Chairman, William E. Youngs; *Secretary-Treasurer,* David E. Strom; *Board of Managers,* Don Duke, Arthur L. Foster and Robert E. Johnson.

Education, Industry News

Three technical graduate assistantships in motion-picture production, television production and photo-journalism will be offered next year by Boston University's School of Public Relations and Communication. The stipend will amount to $1200, plus tuition. The University also offers teaching fellowships in various fields of communication. Scholarships offered include Boston University News Bureau (5), $950 for the academic year; WGBH Graduate Scholarships (15 TV and 1 FM), $1500 for the calendar year; WBUR Graduate Assistantships (3), FM Radio Station operated by Boston University School of Public Relations and Communications; Harold E. Fellows Memorial Scholarship, $500 for a year of graduate study in Broadcasting. Other graduate assistantships are available with a stipend of $400 and undergraduate scholarships with a stipend of $200. Applications must be submitted no later than March 1, 1961. Full information is available from Melvin Brodshaug, Dean, Boston University School of Public Relations and Communications, 640 Commonwealth Ave., Boston 15, Mass.

Utah State University has announced the installation of new television studio facilities and equipment for broadcasting to homes as well as to University classrooms. The new equipment was installed by the Radio Corp. of America. Plans are underway to include the public schools of nearby counties in a system of expanded television teaching. The University has made application to the FCC for adding VHF transmitting facilities to the studio and tape-recording complement now being installed.

The American Film Festival, held under the auspices of Educational Film Library Assn., 250 W. 57 St., New York 19, has announced a new category of films to be shown at the Festival, April 21, 1961, at the Barbizon-Plaza Hotel, New York. This category, called Independent Film-Makers Showcase, was created to encourage independent producers of 16mm creative and experimental films made "for love rather than money." The films will be selected by a committee made up of members of the American Federation of Film Societies. No entry fee will be charged and the showings will be noncompetitive. Certificates of Honor will be presented to producers of films selected for Showcase screenings. Entries of independent producers are also welcome in the Film as Art competition category for which an entrance fee is required. The no-entrance-fee privilege of the new Showcase was decided upon to encourage young producers working with low or no budgets.

The IRE International Convention will be held March 20–23, 1961, at the Waldorf-Astoria Hotel and New York Coliseum, New York. More than 70,000 engineers and scientists are expected to attend. A total of 275 papers, covering the most recent developments in the fields of the 28 IRE Professional groups, have been scheduled for presentation in 54 sessions. High point of the program is a special symposium on new energy sources scheduled for Tuesday even-

Spotlight on

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ing, March 21, at the Waldorf. The complete program will be announced during January. The IRE Show, which will fill all four floors of the Coliseum, will accommodate approximately 850 exhibitors.

A technological assistance and licensing agreement between Litton International S.A., of Zurich, Switzerland, a wholly owned subsidiary of Litton Industries, Inc., of Beverly Hills, Calif., and Kobe Kogyo Corp., of Kobe, Japan, has been approved by the governments of the United States and Japan. The agreement establishes a long-term working relationship in the microwave tube field between Kobe and Litton International. Under the terms of the agreement, Kobe Kogyo has the right to manufacture tubes with Litton proprietary developments for customers in Japan and several other Asian countries. In return for an initial disclosure of information, Litton International receives an equity position in Kobe Kogyo. The agreement also calls for Litton International to receive a royalty fee with a guaranteed minimum, and distribution rights in the United States and most of the world for tubes manufactured by Kobe Kogyo, with the exception of tubes for home amusement products.

The assets of Producers Service Company of Burbank, Calif., have been acquired by Boothe Leasing Corp. of 315 Montgomery St., San Francisco 4, as part of an expansion program by the latter firm which has now extended its operations in the leasing of machinery and equipment to include motion-picture and television industries. Announcement of the transaction was made jointly by the two firms. Producers Service, which is engaged in the leasing of photographic equipment, will be known as Boothe's Producers Service Division. Optical printers and similar equipments will be manufactured for the new division by Photo-Sonics Corp.

Plans for opening a new plant about the middle of January have been announced by Foto-Video Electronics, Inc. The building, located at 75 Factory Place, Cedar Grove, N. J., is a one-story steel and brick structure occupying an area of 30,000 sq ft.

Eight additional foreign dealers have been appointed to represent Magnasync Corp's Studio and/or Nomad Divisions. The new representatives are: General Cine, Brussels, Belgium; Gordon Cameras, London; Gerard Johannsen, Hilden, Dusseldorf, Germany; Christos Axarlis, Athens, Greece; C. N. V. Kinotechniek, Amsterdam, Holland; Audiovicentro, Mexico 7, Mexico; Devalle Hermanos, El Globe, Curacao, Netherlands Antilles; Eugen Ernst, Zurich, Switzerland. The firm, located at 5546 Satsuma Ave., North Hollywood, is engaged in the development and manufacture of magnetic film recording systems.

Joseph I. Quateman has been appointed General Manager of the Professional Division of Bell & Howell. In addition to his new duties he will continue to serve as Director of Special Products Engineering.

Charles P. Ginsburg, who headed the group of researchers whose work resulted in the development of the Ampex Video Tape Recorder, has received the Valdemar Poulsen Gold Medal. The first native-born American to receive the award, he is the sixth person so honored since the award was established in 1939. The award is presented to a radio engineer or scientist in recognition of important contributions to the development of the science or art of radio communication or magnetic registration. The Valdemar Poulsen Gold Medal Foundation is administered by the Danish Academy of Technical Sciences and recipients are chosen on the basis of recommendations from competent institutions in Denmark and abroad.

Presentation of the Medal was made by Carl Schroder of Copenhagen, Vice-President of the Academy, during special ceremonies held November 23, in San Francisco. Presentation of the Medal is traditionally made on that day, which is the birthday of Valdemar Poulsen, born November 23, 1869.

Mr. Ginsburg is now a Vice-President of Ampex Corp. and serves as Manager of Advanced Video Development. Among other honors, he was awarded the David Sarnoff Gold Medal, by the Society, in 1957.

Fred F. Pfeiff has been appointed Technical Manager of the Norelco Motion-Picture Division of North American Philips Co. In his present post he will supervise Norelco 70/35 Projector installations and service activities. Prior to his present appointment he was Chief Engineer of the Theatre Equipment Division of the Todd-AO Corp., the original distributors of the Norelco 70/35 Projector. In that capacity he supervised more than 100 installations of 70mm equipment in the United States and Canada. His earlier experience included a post with the Acoustic Department of Electrical Research Products, Western Electric, which subsequently became the present Altec Service Co.

Donald Creswell, sales representative for Ampex Professional Products Company, has been transferred to the firm's Midwest district with headquarters in Chicago. His territory formerly comprised the States of Pennsylvania, Delaware, Virginia, West Virginia, North Carolina and Maryland. His successor is Richard Sirinsky.

A new division of Reeves Broadcasting and Development Corp. has been announced by Hazard E. Reeves, President. The new division, formed by a merger of Reeves Sound Studios, Inc., and Reeves Products, Inc. is known as Reeves Sound Studios. It was also announced that facilities at 304 E. 44 St., New York, will be expanded to include new video-recording studios to enable the mixing or re-recording of several video tapes into a composite master tape from which copies can be made for TV release. It is also planned to install a coaxial cable network through telephone company facilities to join the studios with production centers and advertising agencies so that programs originating in the studios can be broadcast over closed circuit to the advertising agencies.

section reports

The Boston Section held its first meeting of the fall season on November 9. Thirty-six members and guests met at the WBZ-TV Auditorium to hear a discussion of "The Photographic Reproduction of Color with Specific Reference to the Unique Properties and Structure of Kodachrome," by Charles B. Rockwell, III, President of Rockwell Films, Inc., Cambridge Mass.

Mr. Rockwell discussed the theory of color reproduction with particular reference to the Kodachrome emulsion. Some of the problems encountered in the processing of Kodachrome were discussed. Following his talk, a lively question-and-answer session developed, with many in the audience participating.

The new Board of Managers, Section Chairman and Secretary-Treasurer for the next year were introduced at the beginning of the meeting. Ed Rideout, the retiring chairman, was given a vote of thanks for his work in organizing the Boston Section and for his service as the Section's first chairman.

The Board of Managers and the speaker met for dinner at the Reservoir Club in Cambridge prior to the meeting.—Robert M. Fraser, *Secretary-Treasurer*, c/o Itek Corp., Waltham 54, Mass.

The Canadian Section met on November 17 at the Main Studio of Peterson Productions Ltd. in Toronto with an attendance of 31. Guest speakers were Rodger J. Ross of the Canadian Broadcasting Corp., who discussed "Control Techniques in Film Processing," and Arthur Dinnen, The Bell Telephone Co. of Canada Ltd., whose subject was "The Trans-Canada Micro-Wave System."

Mr. Ross presented an introduction of the new SMPTE book, "Control Techniques in Film Processing." Colored slides were used to highlight the important sections of the book. The speaker encouraged members to obtain the book and to assist in its distribution.

Chetwynd Films Ltd. were hosts at a coffee break during a brief intermission.

Mr. Dinnen employed a descriptive film showing the construction problems of the "Trans-Micro Wave System" and demonstration equipment to illustrate its operation. In addition to telephone channels, the Micro-Wave System provides Canada's basic coast-to-coast television network.

Prior to the meeting the speakers and several section officers met at the Town and Country Restaurant for dinner.—R. B. Mackenzie, *Programme Chairman*, Toronto Group, c/o Mackenzie Equipment Co., 433 Jarvis St., Toronto 5, Ont.

The Chicago Section met on November 22 at Stauffer's Restaurant with an attendance of 78. Guest speakers were: Mike Neigoff, WBBM-TV, News Reporter, whose subject was the "Function of the News Department"; Lou Bartlow, WBBM-TV, Administrative Assistant to the News Director, who discussed "Planning of News Coverage"; Maurie Bleckman, WBBM-TV, News Cameraman, who described "Photographing News Events"; Bill Tyler, WBBM-TV, Sound Engineer, who talked about "Recording Sound for the News"; and Ike Bartimoccia, Cinema Processors, whose topic was "Laboratory Function in News Photography."

Mr. Neigoff described the overall function of the news department and the philosophy of news reporting. The extensive use of motion-picture film is based on the premise that film can tell a story in a way that no other reporting medium can. Necessarily, films used on the air are chosen primarily for their news-giving value rather than aesthetic qualities, but every effort is made to maintain a high standard of picture quality.

Detailing the station news operation, Mr. Bartlow told of the planning involved in getting the right man on the spot at the right time to get the story and then to get it on the air while it is still "fresh."

Messrs Bleckman and Tyler, who comprise one of the station's news reporting teams, described their function in the fast-moving business of getting the news on film. This often includes shooting at several locations in order to develop a single story comprehensively.

A graphic report of the laboratory func-

tion was presented by Mr. Bartimoccia. Film was shot, newsreel fashion, of the opening of the meeting. This film was rushed to the Lab, processed and printed and a positive sound print was back on the screen in the meeting room within 45 minutes. The excellent picture quality was a tribute to the abilities of his unique organization.

A question-and-answer session followed the speakers' presentations and continued throughout the coffee break which closed the formal meeting.—Philip E. Smith, *Secretary-Treasurer*, c/o Eastman Kodak Co., 1712 S. Prairie Ave., Chicago 16, Ill.

The Dallas-Fort Worth Section met on December 8 at the new WFAA-TV-FM-AM Studios in Dallas with an attendance of 42. George Krutelik of WFAA-TV escorted the group on a tour of the studio facilities.

Mr. Krutelik and his engineering staff talked before conducting the group on the tour of the studio which is presently under construction. Detailed blue prints and engineering drawings were available for study by the group.

Coffee and doughnuts were served through the courtesy of our hosts.—M. D. McCarty, *Secretary-Treasurer*, 4401 Wildwood Rd., Dallas, Texas.

The Hollywood Section met on November 15 at the ABC Studio with an attendance of 25. Guest speakers were: Dr. John E. Coulson, Systems Development Corp., who discussed "Automated Instruction"; Marc Bendick, Systems Development Corp., whose topic was "Theory and Design Automated Instructions: Hardware and Logic"; and Russell J. Tinkham, Vega Electronics Corp., who described "The Vega-Mike Wireless Microphone System."

Both Mr. Bendick and Dr. Coulson described their work in the field of automated instruction, i.e., teaching machines. Dr. Coulson gave a brief history of the development of teaching machines and discussed the theoretical concepts upon which teaching-machine usage and design is based. Mr. Bendick described various hardware involved in current research projects, and, specifically, the development of a random access, 600-slide projector used for presenting instructional material when actuated by a computer.

A very interesting and effective presentation was made by Mr. Tinkham who described and demonstrated the new Vega-Mike wireless-microphone system. The transistorized FM transmitter, microphone, and battery supply are all contained in a cylindrical housing approximately 4 in. long and 1 in. in diameter. The receiver operates from 25 to 45 mc, with a simple tuning arrangement. These RF microphones have been used recently on several network broadcasts with excellent results.—Ralph E. Lovell, *Secretary-Treasurer*, 2554 Prosser Ave., Los Angeles 64.

The Nashville Section met on November 19 at the Baptist Sunday School Board with an attendance of 18. Guest speaker Charles O'Rork, freelance director of photography, discussed "The Camera as a Tool."

Mr. O'Rork actually conducted an informal discussion and demonstration meet-

ing rather than giving a formal talk. He brought a variety of 16mm and 35mm films which he screened in parts to illustrate his points. For example, he showed a jungle-survival print made for the Air Force and then told the group how he got sufficient light into a rain forest and how he manufactured rain when he was miles away from his normal rain-making equipment.

After screening the illustration sections, the speaker answered questions and presided at a round-table discussion. He also displayed still photographs to illustrate many of his location setups.

Coffee and pastries, compliments of the Sunday School Board, were served during an intermission.

This meeting was of special interest to the film people in the group. Following the meeting, members of the group were dinner guests of Motion Picture Laboratories.—Frank M. McGeary, *Secretary-Treasurer*, c/o Motion Picture Laboratories, Inc., 781 S. Main St., Memphis 6, Tenn.

The New York Section met on November 9 at the World Affairs Center Auditorium with an attendance of 95. Guest speaker Dr. Sigmund A. Brahms, Associate Radiologist, Mt. Sinai Hospital, discussed "Cinefluorography."

Dr. Brahms has become outstanding throughout the medical profession for his work with cinefluorography. His paper covered the cine radiography of an electronically intensified fluoroscopic image. This method makes possible the use of a lower level of radiation for a shorter period of time with greater safety for the patient. He demonstrated with slides and a 16mm motion picture the unique results obtainable by this system, including simultaneous radiographs from two directions. After the social period Dr. Brahms commented on the possible use of the electronically intensified fluoroscopic image for stereoscopic cinefluorography.—James W. Kaylor, *Secretary-Treasurer*, c/o Movielab Film Laboratories, Inc., 619 West 54 St., New York 19.

The Rochester Section met on November 18 at the Kodak Office Auditorium with an attendance of 180. Dr. Norwood L. Simmons of Eastman Kodak Co., President of SMPTE, addressed the group. His subject was "Hollywood's Split Personality."

Dr. Simmons exemplified through film clips and slides what has happened to Hollywood in the past ten years. Contrary to many of the opinions prevalent today, Hollywood is as busy, or busier, than it ever was before. Where once its mainstay was theatrical productions, it now finds itself greatly involved with theatrical productions, television commercials and industrial films.

Dr. Simmons showed examples of material produced in each of these areas. He correlated the changes to the growth in television mainly, but also showed the effects from industrial uses of film. This program attracted many people in Rochester to the meeting. Dr. Simmons did an excellent job and many noted that it was a good program, well presented.

We enjoyed having Dr. Simmons with us and we feel particularly honored that he chose to speak to our Section. This was one of the last public functions of Dr. Simmons in his capacity as President of the SMPTE.

Business of the Section, including discussions of plans to continue active and well selected programs for the coming year, were the subject of a meeting of officers held prior to the evening session. The officers-elect for 1961 were acquainted with their new duties in order to promote mutual understanding and transfer of functions of retiring officers.

Congratulations to the Section Chairman-Program Director team of Messrs. Connor-Johnson for a very successful year —a job well done for SMPTE. Best wishes to Eric Johnson, new Section Chairman.—W. G. Hill, *Secretary-Treasurer*, 10 Hillcrest Ave., Binghamton, N.Y.

The San Francisco Section met on November 15 at the Fairchild Semiconductor Corp.'s facility in Mountain View, Calif. with an attendance of 15. Guest speakers Bob Merrick and Ran Johnston, both of Fairchild, discussed transistors, their specifications and methods of manufacturing.

After seeing a 15-min movie and hearing a discussion of various types of transistors, Messrs. Merrick and Johnston gave us a tour of the plant. Every step used in the manufacture of a silicon transistor was shown and explained. The steps shown were: (1) silicon-crystal growing and the quality and quantity control of the added impurities; (2) the cutting of the silicon crystals into thin wafers; (3) polishing the

wafers; (4) diffusion of the wafer with a gas of certain chemical characteristics in a 2000 F oven; (5) metal evaporated onto the wafer and then onto a photo-etching process; (6) soldering to the header; (7) attaching of the leads to the active members of the transistors; (8) cleaning and capping.

The group was well impressed with the extreme caution and quality control that is used by Fairchild in its products.—Frank Mansfield, *Secretary-Treasurer*, 57 Stoneyford Ave., San Francisco 24.

Abstracts

Abstracts from other Journals, chosen for importance and timeliness, are published in the *Journal* from time to time. The greater number of these abstracts are translations, chiefly from the U.S.S.R., and made available by the *Kodak Monthly Abstract Bulletin*.

The subject areas are grouped below:

Color Photography and Color Development
Film and Its Properties
Film Processing Apparatus and Chemicals
Projection
Sensitometry and Image Structure
Sound Recording and Reproduction
Television

COLOR PHOTOGRAPHY AND COLOR DEVELOPMENT

Russian Pat. 113,492. Method of Processing Multilayer Photographic Materials With Color Development, V. K. Miloslavov. Filed Mar. 21, 1957. Abstracted in *Tekh. Kino i Televideniya, 4:* 89, Mar. 1960.

After fixing, the soundtrack is coated separately from the remainder of the film with a viscous solution of a hypo-destroyer, e.g., an aqueous solution of iodine and potassium iodide, saturated with Tylose [methylcellulose], after which it is immersed in a bleaching bath, and further separate processing of the soundtrack and the color image is carried out by one of the known methods. To eliminate the last hypo solution, materials provided with a filter layer of metallic silver are coated following a short immersion of the film in a bleaching bath, after which the film is again immersed in the bleaching bath so as to finish the bleaching process. It is shown that, if the film is processed by the method described in Russian Pat. 82,276, the optical density of the silver remaining in the soundtrack does not exceed 0.5; on processing by the proposed method, the optical density of the soundtrack reaches 1.25.—S. C. G. (Translated from *Tekh. Kino i Televideniya*.)

Russian Pat. 113,021. Method of Preparing the Receptive Layer of Matrix Film for the Imbibition Process of Printing Color Films, S. M. Levi, S. E. Tikhonovich, O. K. Smirnov, N. S. Spasokukotskiĭ and E. D. Korneva. Filed Aug. 13, 1957. Abstracted in *Tekh. Kino i Televideniya, 4:* 89, Mar. 1960.

A method of preparing the receptive surface of matrix film is described which does not need supplementary hardening

before the imbibition transfer and also ensures a high-quality image. The method consists in introducing into the silver halide emulsion, before coating the receptive surface, a mixture of the simple esters of methylolmelamine with formaldehyde (from 1 to 4% based on the weight of methylolmelamine) in the form of a 10% aqueous solution in quantities not less than 4% based on the weight of the gelatin, instead of the usual tanning agent. It is claimed that color images obtained on matrix film with the receptive surface described are equivalent to color images obtained by the best of the known methods, and are superior to them in the uniformity of the dye imbibed.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

FILM AND ITS PROPERTIES

Use of Ultrasonics in the Manufacture of Photographic Emulsions (in Russian), S. A. Neduzhiĭ, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, No. 28, 133–147, 1959.

A review is given of papers devoted to the applications of ultrasonics in the manufacture of photographic emulsions.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

The Elaboration and Study of a Contact Method of Measuring the Dimensions of Motion-Picture Film (in Russian), L. K. Kutaĭ, A. Ya. Galnykin and V. S. Stepanov, *Trudy Leningrad. Inst. Kinoinzhener*, No. 5, 116–122, 1959.

The problems encountered in a contact method of measuring the geometrical dimensions of film are considered, particularly the pitch and height of perforations. A description is given of the design and construction of the original Soviet PKP-2 apparatus developed in the institute of the authors of this article. From laboratory and practical tests of the PKP-2 apparatus, the advantages of the contact method of controlling motion-picture film were determined and recommendations are given for the development of a continuously working apparatus which would make it possible to control the geometrical dimensions of the film during production.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

Some New Motion-Picture Films (in Russian), V. L. Abritalin, *Tekh. Kino i Televideniya, 4:* 74–83, Apr. 1960.

Data on a number of foreign (i.e., non-Soviet) motion-picture films are collected from the literature, and the results of a large number of comparative tests are reproduced. These include physical, structural, chemical, sensitometric and resolution characteristics.—S. C. G.

FILM PROCESSING APPARATUS AND CHEMICALS

Standard Specifications for Silver Recovery, I. V. Blyumberg, S. G. Gurevich, F. S. Matison and T. A. Novatskaya. *Trudy Leningrad. Inst. Kinoinzhener*, No. 5, 210–218, 1959.

For specifying a standard for the recovery of silver, the following were determined experimentally: silver-coating weights for black-and-white and color emulsions from different factories, the silver content in images on black-and-white and color positives, and the loss of silver in the machine and in the fixing and bleaching solutions. On the basis of the results, calculations have been made for a suggested standard for silver recovery which is higher than the standard in operation since 1948.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

A Study of the Fundamental Parameters in the Jet Processing of Black-and-White Motion-Picture Film, B. V. Valul'skiĭ, *Tekh. Kino i Televideniya, 4:* 44–51, May 1960.

A theoretical hydrodynamic analysis is made of the development and fixing of moving motion-picture film by means of jets, the jets being applied vertically to a horizontal film, and confirmatory experiments are described. The major factors are the rate of application of the jets and the degree of overlapping of the streams on the film surface. The effect of temperature in this type of processing is similar to that of temperature in processing in tanks with agitation. Application normal to the surface of the film was found to be more effective than tangential application.—S. C. G.

The Film-Advance Speed Stabilizer of the 25KTK-1 Printing Machine (in Russian), A. M. Melik-Stepanyan. *Informatsionno-Tekh. Byull. TsKB Minist. Kultury S.S.S.R.*, No. 1 (20), 19–29, 1959; *Tekh. Kino i Televideniya, 4:* 93, Apr. 1960.

PROJECTION

Russian Pat. *114,146*. Film Gate for Motion-Picture Projectors (in Russian), A. M. Bolokhovskiĭ. Filed April 23, 1952. Abstracted in *Tekh. Kino i Televideniya, 4:* 88, Mar. 1960.

To eliminate possible damage to the picture on a motion-picture film from dirt building up in the gate and from products of wear of the film causing pressure, the film gate is made in the form of two separate flanges of angular cross section, one of which is fixed and the other is supported on springs. The gate is curved, which eliminates squeezing of the film on the side toward the center of curvature of the gate, both while the film is moving and while it is stationary.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

Stereo Screens With Reflecting Surfaces and Diaphragms (in Russian), B. T. Ivanov and E. N. Bushueva. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, No. 31, 122–133, 1959.

Basic Parameters for the Calculation of Stereoscopic Projection Without the Use of Spectacles (in Russian), B. T. Ivanov and S. A. Panina. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, No. 31, 45–71, 1959.

The Geometrical Laws of Taking and Projecting Stereo Films (in Russian), A. G. Boltyanskii and N. A. Ovsyannikova. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, No. 31, 4–28, 1959.

The Experimental Grounds for the Magnitude of the "Infinity" Parallax in the Stereo Cinema (in Russian), N. I. Gol'tsman, E. M. Belostotskii and E. N. Semenovskaya, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, No. 31, 29–44, 1959.

Measurement of Forces in a Motion-Picture Projector (in Russian), A. Bodrov, *Kinomekhanik*, 24–8, Jan. 1960.

A dynamometer is described for the measurement of forces, both of tension and compression, acting on film passing through a projector and on the parts of the projector itself. Forces acting at a number of selected points in Soviet cameras are tabulated.—S. C. G.

Automatization of the Screening of Films (in Russian), V. Mun'kin, *Kinomekhanik*, 20–23, Jan. 1960.

Consideration is given to the technical requirements of systems for the automatic change-over from projector to projector during a film show, based on experience in Soviet theaters and at the NIKFI laboratories.—S. C. G.

Cinematograph Projection by the Two-Objective System (in Russian), N. D. Bernshteĭn, D. R. Khanukaev and G. V. Mering. *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, No. 31, 88–101, 1959.

A description is given of a stereoscopic motion-picture projector for projection by the two-objective system. It is shown that this system of taking and projecting stereo films gives a better-quality reproduction of spatial relations than earlier systems did. The stereo projector and adjustments during stereo projection are considered.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

Method of Determining the Basic Parameters of Stereoscopic Cinematograph Projection With a Grid (in Russian), L. V. Akimakina, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, No. 31, 83–87, 1959.

It is shown that the coefficient of separation is not the only important magnitude affecting the quality of stereoscopic projection on a grid screen. The shape and dimensions of the working area of the zone of stereo viewing must also be taken into account. The parameters of the zone of stereo viewing and the magnitude of the working area determine the degree of comfort of the viewers in the perception of the stereo image on the grid screen.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

A Sighting Device for Grid Stereoscopic Projection (In Russian), N. I. Gol'tsman and V. S. Shchekochikhin, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, No. 31, 102–107, 1959.

A sighting device is described which allows the viewer at any moment during the showing of a stereo film to find, quickly and accurately, the correct position in relation to the zone of stereoscopic viewing. It is shown that the use of the sighting device decreases the fatigue of the viewers and improves the conditions of observation of the stereoscopic image.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

Auditorium Parameters of Giant Cinemas, E. M. Goldovskii, *Tekh. Kino i Televideniya, 4:* 25–36, May 1960.

The problem of the shape and dimensions of auditoriums in giant motion-picture theaters is considered. Starting from the conditions under which the screen is viewed, relations are established to allow the choice of the basic parameters of auditoriums for the screening of normal, wide-screen, wide-format and panoramic films. It is shown that an auditorium shape can be found which is satisfactory for all types of exhibition. Formulas necessary for the calculation of auditorium dimensions and the choice of projection equipment are given.— S. C. G. (Translation of Author's Abstract.)

The KSS-35 Motion-Picture Projector (in Russian), V. Petrov and I. Fonar', *Kinomekhanik*, 35–42, Jan. 1960.

The NIKFI laboratories, in collaboration with industry, have produced a new type of stationary projector in two forms: one for theaters seating 400 persons and another for those seating up to 200. The difference between the two lies in the lighting system: a xenon lamp for the higher power, and a tungsten lamp for the lower. The mechanical and optical systems are described.—S. C. G.

Lighting Systems for Stereo Cine Projectors (in Russian), T. V. Derbisher, *Trudy*

Vsesoyuz. Nauch.-Issled. Kinofotoinst., No. 31, 72–82, 1959.

On the basis of the analysis of different lighting systems for stereo motion-picture projectors, two types of systems are suggested: (a) a compound mirror and (b) a honeycomb condenser. It is shown that, although systems with the honeycomb condenser are less economical (in comparison with systems with a compound mirror), they must be recognized as more convenient for illuminating the gate of a stereo projector.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

SENSITOMETRY AND IMAGE STRUCTURE

Russian Pat. 113,884 **Method of Establishing a Development Schedule and a Device for Realizing the Method,** S. M. Khazan. Filed July 10, 1953. Abstracted in *Tekh. Kino i Televideniya, 4:* 89, Mar. 1960.

Two different densities lying on the straight-line portion of the characteristic curve and obtained with a constant exposure interval previously chosen are printed onto a positive material, the greater density being printed directly and the smaller through a continuous wedge. After development, a point is found on the print of the wedge, for which the sum of the densities of the wedge and the smaller density of the photographic material under test is equal to the greater density of the same material. From the value of the wedge density which it is necessary to add in order that the greater and smaller densities should be equal, the amount of development is reckoned.—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

Influence of the Rate of Development on the Reproduction of Picture Detail by a Photographic Material (in Russian), G. V. Derstuganov, *Tekh. Kino i Televideniya, 4:* 53–57, Apr. 1960.

The "Photographic Information Volume" of Kardas (*Phot. Eng., 5:* 91, 1954; *6:* 190, 1955) is not suitable in its original form for the study of the reproduction of detail at low contrast. An index of the performance of a photographic material at a given contrast has therefore been obtained by taking the area of the cross section of the volume at a given contrast of the test object. This corresponds to taking the area under the curve $R' = f(\log E)$ at a given constant contrast. A further refinement is to take the "useful" area lying above the ordinate $R' = 5\ \text{mm}^{-1}$, R' being the resolving power in lines per millimeter. This characteristic has been given the symbol U_p. Experiments were carried out by exposing a photographic material to a test object and studying the effect of time of development U_p and sensitometric characteristics. It was found that increasing the rate of development, either by increasing the concentration of the developing agent or by raising the temperature, produced a deterioration in the rendition of low-contrast detail, which was expressed quantitatively be a decrease in U_p. At the same time, the properties of the photographic material markedly affected the decrease in U_p. When three different types of material were tested in Metol-hydroquinone developers, an increase in the rate of development produced a relatively greater fall in U_p for a high-speed, coarse-grain film than for a slow-speed, fine-grain film. For any given case, the decrease in U_p was greater, the smaller the detail contrast.—S. C. G.

SOUND RECORDING AND REPRODUCTION

Dynamic Range Compression in Film Re-Recording (in Russian), E. V. Nikul'skiĭ, *Tekh. Kino i Televideniya, 4:* 66–67, Apr. 1960.

Evaluation of Distortions Caused by Different Noise-Reduction Systems in Variable-Area Photographic Recording (in Russian), A. A. Yur'ev, *Tekh. Kino i Televideniya, 4:* 31–38, Apr. 1960.

The Number of Sound-Reproducing Channels Required for Stereophonic Motion-Picture Films, N. Z. Vysotskiĭ, *Tekh. Kino i Televideniya, 4:* 37–42, May 1960.

The requirements of stereophonic sound for wide-screen and panoramic systems are considered. It is concluded that three to five channels will give a satisfactory stereophonic effect for wide-screen systems and panoramic systems with an angle not greater than 180°. Larger panoramic systems require as many as ten channels, and future systems may require more. However, the difficulties of mass production of prints bearing a large number of channels and other considerations suggest that the number of channels should be restricted to six.—S. C. G.

TELEVISION

The Quality of the Motion-Picture Television Image in the Production of Films by the Electronic Method, V. A. Burgov, *Tekh. Kino i Televideniya, 4:* 4–12, May 1960.

By the electronic method of filming is meant the coverage of the scene with a television camera and the subsequent photography of the kinescope image. An analysis is made of the resolving power of the photographic material as a function of frequencies in the image, and on this basis, the reproduction of the frequencies occurring in the television image are discussed. Maximum reproducible frequencies for various types and formats of motion-picture film are worked out. The combined influence of the television and motion-picture reproduction on the quality of the image is discussed, and, finally, consideration is given to possibilities of improving the quality of pictures made by this method.—S. C. G.

An Investigation of the Brightness Distribution Law in a Transmitted Image on a Probability Basis, N. N. Krasil'nikov, *Tekh Kino i Televideniya, 4:* 21–24, May 1960.

A law of brightness distribution in the transmitted image and a law of amplitude distribution in the television signal are put forward. They have been found experi-

mentally, and a method of carrying out the experiments is also described. On the basis of the results so obtained, a function has been found which gives a good approximation to the law of brightness distribution in the image.

Examples of the use of the results are given; in particular, it is shown that the use of positive modulation in the television transmitter is more suitable and makes possible a decrease in the average oscillatory power of the latter, for example, by 1.82 times, in comparison with negative modulation.—S. C. G. (Translation of Author's Abstract.)

An Electronic Switch for Photography From the Kinescope Screen (in Russian), B. P. Khromoĭ, *Tekh. Kino i Televideniya, 4:* 71–73, May 1960.

The electronic circuit described operates the shutter of a camera so that a single complete frame of a television picture can be recorded.—S. C. G.

Anglo-French Microwave System

Microwave (SHF) radio systems have taken their place beside coaxial cable and other long established carrier line systems as a reliable medium for high quality, long distance communications. Installations are presently operating in Austria, Canada, Great Britain, Brazil, Japan, Spain, Switzerland and Malaya.—*International TV Technical Review, 1:* 18–21, May 1960.

A Common Carrier Multi-Channel Television Wire Broadcasting System

The factors governing the choice and design of a television relay system and the history and background of the development of various systems are surveyed. The basic technical features of a system carrying four television and four radio programs are discussed. Information is given regarding the various types of cable and their specifications. Network jointing and matching fittings are described and the method of using the system characteristics to plan a network is explained with examples and an indication of the sort of coverage that can be obtained. Various types of subscriber installations can be provided and their characteristics are defined and typical examples given of subscribers equipment. The operation of the main receiving station and repeater equipment is explained in some detail and finally test methods and test equipment are described.—K. A. Russell and F. Sanchez, *Jour. Brit. IRE, 20:* 497–512, July 1960.

Flying-Spot Scanners for Colour Television

Flying-spot scanners for colour television are of interest chiefly because, in principle their signals are completely free from errors of superposition or "register." Two types of flying spot scanner have rendered valuable service in development work on colour television at Philips. One is suitable for colour slides, the other for opaque objects (colour prints, drawings, small objects, etc.) Both types probably have a useful part to play in colour television broadcasts.—H. van Ginkel, *Philips Technical Review, 21:* 234–250, June 1960.

Microwave Valves: A Survey of Evolution, Principles of Operation and Basic Characteristics

After a brief description of the evolution of the different classes of microwave valves, the principle modern types are discussed under the headings of their mode of operation: "O" type interaction, "M" type (crossed field), variable reactance amplifiers, and the maser. A brief survey of the performances obtained are given. Included are 89 references.—C. H. Dix and W. E. Willshaw, *Jour. Brit. IRE, 20:* 577–609, Aug. 1960.

The Power Gain of Multi-Tiered VHF Transmitting Aerials

Transmitting aerials for VHF broadcasting usually consist of a number of similar groups or tiers of radiating element, spaced at intervals along a supporting mast. The power gain of such an arrangement depends on the number of tiers, on the spacing between them, and also on the vertical radiation pattern of each individual tier. A method of calculating the gain is described. Results computed for a comprehensive range of variables are presented in the form of tables.—P. Knight and G. D. Monteath, *BBC Engineering Division Monograph, No. 31:* July 1960.

Some Aspects of Vidicon Performance

The performance of the 1-in. vidicon is discussed, particularly the effect of various operating conditions on transfer characteristics, lag, resolution and geometry. When target voltage and dark current are high, maximum sensitivity is obtained, but this is at the expense of the other parameters. In the E.M.I. (Electric and Musical Industries) vidicon, the optimum performance as regards γ and lag is obtained for signal currents of 0.2 to 0.3 μA and dark currents of 0.01 to 0.03 μA. Methods of measuring sensitivity, γ and lag are described and possible sources of error indicated. The effect of bias illumination on γ, lag and resolution is analyzed. Improvements in geometry are described together with a method of improving resolution. Infrared and ultraviolet sensitive tubes are mentioned—H. G. Lubszynski, S. Taylor and J. Wardley, *Jour. Brit. IRE, 20:* 323–334, May 1960.

The Stratoscope I Television System

Stratoscope I is a balloon-borne astronomical telescope designed for solar photography. When aloft, the telescope is remotely operated by radio command signals transmitted from a control station on the ground. A special television system has been developed to assist in aiming and focusing Stratoscope I. This equipment comprises a camera and transmitter on the telescope and a ground receiver driving several monitors. It permits the astronomers at the ground control station to visually aim and focus the telescope by inspection of the television monitors. The use of this technique has significantly increased the yield of useful photographs obtained with Stratoscope I.—L. E. Flory, G. W. Gray, J. M. Morgan and W. S. Pike, *RCA Review, 21:* 151–169, June 1960.

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Jan., July, Sept. and Nov. 1949; Jan and Feb. 1950. Century Lighting, Inc. (Mrs. Levine), 521 W. 43 St., New York 36, N.Y.

Feb., Mar., Apr., June 1934. Mrs. Janet Van Duyn, Librarian, CBS Laboratories, 227 High Ridge Rd., Stamford, Conn.

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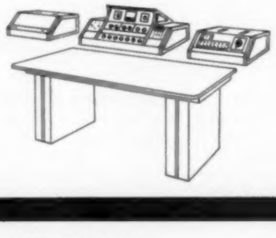

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Advertisers

Meeting Calendar

New England Industrial Photographic Association, 4th Annual Trade Show, Jan. 16–17, Motel 128, Dedham, Mass.

ISA, Winter Instrument-Automation Conference and Exhibit, Jan. 16–19, 1961, Sheraton-Jefferson Hotel & Kiel Auditorium, St. Louis, Mo.

American Astronautical Society, Jan. 16–18, 1961, Sheraton Hotel, Dallas, Tex.

International Solid-State Circuits Conference, Feb. 15–17, Univ. of Pennsylvania and Sheraton Hotel, Philadelphia.

Optical Society of America, Spring Meeting, Mar. 2–4, Pick-Roosevelt Hotel, Pittsburgh, Pa.

ASME, National Aviation Division Conference, Mar. 12–16, 1961, Statler Hotel, Los Angeles.

American Society of Photogrammetry, ASP-American Congress on Surveying and Mapping, Mar. 19–25, 1961, Shoreham Hotel Washington, D.C.

IRE International Convention, Mar. 20–23, 1961, New York Coliseum, New York.

National Microfilm Association, National Convention, Apr. 4–6, 1961, Hotel Sherman, Chicago.

ASTM, Committee F-1 on Materials for Electron Tubes and Semiconductor Devices, Apr. 5–7, 1961, Benjamin Franklin Hotel, Philadelphia.

Inter-Society Color Council, 30th Annual Meeting, Apr. 10–12, Sheraton Hotel, Rochester, N.Y.

ISA, 7th National Symposium on Instrument Methods of Analysis, Apr. 17–19, 1961, Shamrock-Hilton Hotel, Houston, Texas.

DAVI, Apr. 24–28, 1961, Deauville Hotel, Miami Beach, Fla.

ISA, 7th National Aero-Space Instrumentation Symposium, May 1–4, 1961, Fort Worth, Tex.

89th Semiannual Convention of the SMPTE, May 7–12, 1961, King Edward Sheraton, Toronto.

SPSE, Annual Conference, May 8–12, 1961, Arlington Hotel, Binghamton, N.Y.

IRE Professional Group on Microwave Theory and Techniques, National Symposium, May 15–17, Sheraton-Park Hotel, Washington, D.C.

AIEE, ARS, IAS, IRE, ISA, National Telemetering Conference, May 22–24, Sheraton Towers Hotel, Chicago.

ASME, Semiannual Meeting, June 11, 1961, Los Angeles.

AIEE, Summer General Meeting, June 18–23, 1961, Ithaca, N.Y.

AIChE, AIEE, ASME, IRE, ISA, Joint Automatic Control Conference, June 28–30, Univ. of Colorado, Boulder, Colo.

IFME, JECMB, IRE-PGBME, 4th International Conference on Medical Electronics and 14th Conference on Electronic Techniques in Medicine and Biology, July 16–22, Waldorf-Astoria Hotel, New York.

NAVA, Annual Convention, July 22–25, 1961, Hotel Morrison, Chicago.

SPIE, National Convention, Aug. 7–10, 1961, Ambassador Hotel, Los Angeles.

Western Electronic Show and Convention, Aug. 22–25, 1961, San Francisco.

UFPA, Annual Meeting, August 1961, Berkeley Campus, U. of California.

PGIT, International Symposium on Transmission and Processing of Information, Sept. 6–8, MIT, Cambridge, Mass.

90th Semiannual Convention of the SMPTE, Oct. 2–6, 1961, Lake Placid, N.Y.

Society of Reproduction Engineers, Visual Communications Congress, Dec. 1–4, 1961, Hotel Biltmore, Los Angeles.

91st Semiannual Convention of the SMPTE, Apr. 30–May 4, 1962, Ambassador Hotel, Los Angeles.

92nd Semiannual Convention of the SMPTE, Oct. 22–26, 1962, Drake Hotel, Chicago.

93rd Semiannual Convention of the SMPTE, Apr. 22–26, 1963, Traymore Hotel, Atlantic City, N.J.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1960 Journal Part II.

sustaining members

of the Society of Motion Picture and Television Engineers

The objectives of the Society are:

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
- Dissemination of scientific knowledge by publication.

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The Society invites applications for Sustaining Membership from other interested companies. Information may be obtained from the Chairman of the Sustaining Membership Committee, Ethan M. Stifle, Eastman Kodak Co., Room 626, 342 Madison Ave., New York 17, N.Y.